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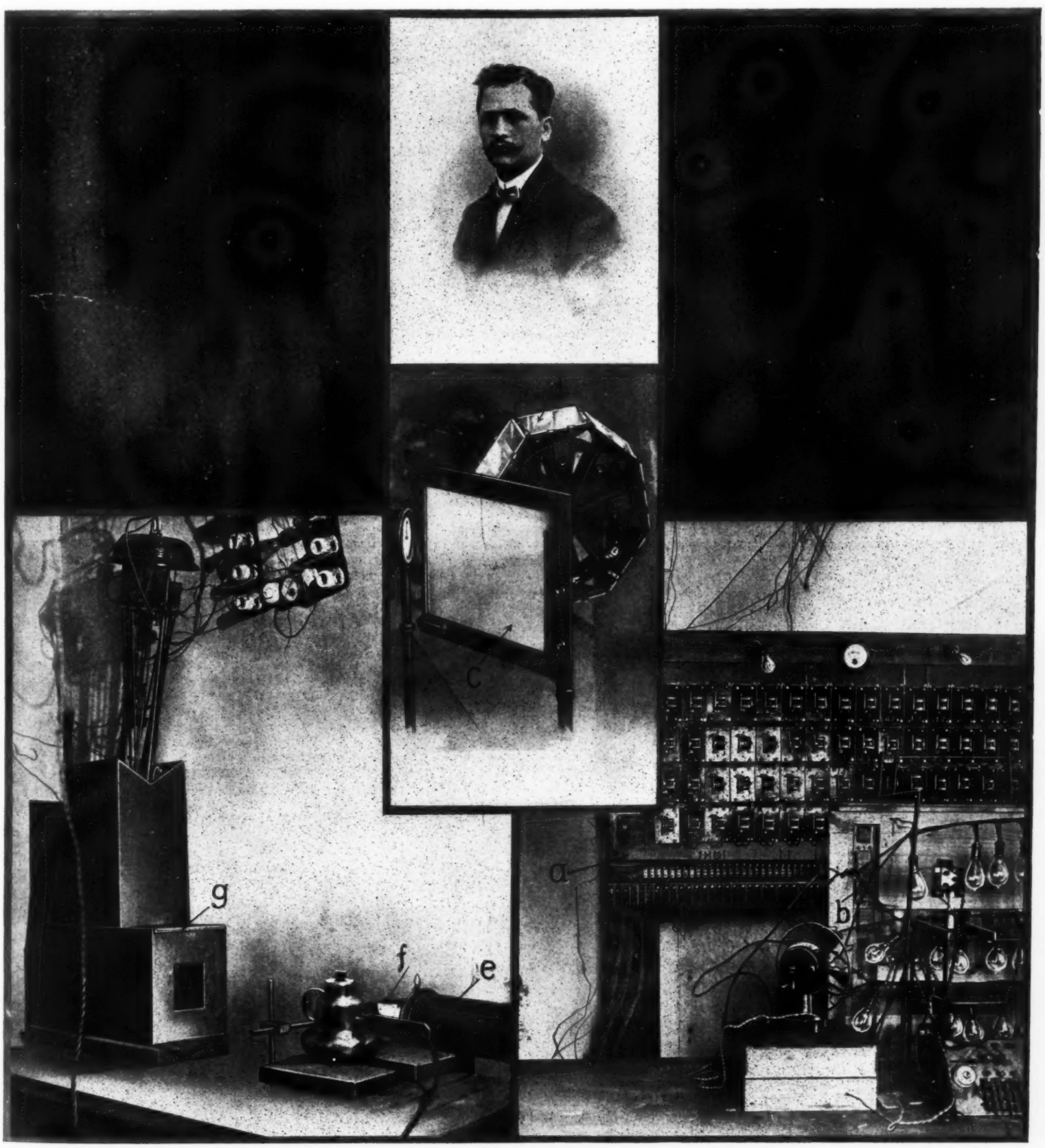


Upper Left-hand Illustration—The letter *C* in the Rignoux receiving mirror. Lower Left-hand Illustration—Receiving station: *e*, solenoid; *f*, nicol prism; *g*, arc light. Center Illustrations—Above: Georges Rignoux. Below: the receiving apparatus: *c*, translucent screen on which the images from the revolving mirror *d* are received. Upper Right-hand Illustration—The letter *L* in the Rignoux receiving mirror. Lower Right-hand Illustration—Transmitting stations: *a*, magnetic relays; *b*, bank of 64 selenium cells.

The Telephotographic Apparatus of Rignoux and Reproductions Showing How the Letters of a Message Appear in the Receiver.—[See page 331.]

Various Forms of the Periscope*

Principles and Development of a Valuable Instrument Used in War

WHILE the periscope of the submarine is developing in the direction of greater optical perfection and elaboration, there has been a return to the simplest and earliest types of periscope for use in land warfare. Some of these trench periscopes recall the polemoscope, described by Helvelius in the seventeenth century for military purposes; this polemoscope in its simplest form consisted of two mirrors with their reflecting surfaces parallel to each other, and inclined at 45 degrees to the direction of the incident light. These mirrors were mounted in a tube and separated a convenient distance (Fig. 1).

For modern trench warfare the convenient separation is about 18 to 24 inches, and the mirrors are mounted

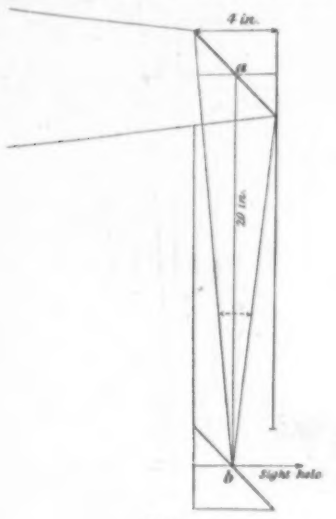


FIG. 1.

in tubes, in boxes of square or oblong section, or attached to a long rod. In each case it is necessary that the mirrors should be fixed at the correct angle, and that there should be no doubling or distortion of the image.

The principal requirements of these trench periscopes are portability, lightness, small size and inconspicuous appearance, and large field of view. When there are no lenses the field of view is exactly the same as would be obtained by looking through a tube of the same length and diameter. Thus, with mirrors of 2 inches by 3 inches and a separation of about 22 inches, a field of view of 5 degrees would be obtained; and by moving the eye about, this field could be nearly doubled.

By using a box of oblong section the horizontal field of view can be increased without unduly increasing the size of the periscope. As the field of view is somewhat limited in any case, the principal objection to the use of a telescope or binocular, viz., the reduced field, no longer applies, and many periscopes are arranged to be used with a monocular or a binocular telescope.

Most periscopes can be used with a magnification of two or three, i. e., with one tube of an ordinary opera glass; but when higher magnification is to be used the mirrors must be of better quality, both as regard flatness of surfaces and parallelism of the glass. When the mirrors are large enough—8 to 10 centimeters wide—both telescopes of the binocular may be used, but in this case the requirements for the mirrors are even more stringent, as the images formed by the two telescopes will not coincide unless the mirrors are plane. When suitable lenses are placed between the mirrors, the size of the mirrors can be reduced or the field of view increased; it is easy to provide a small magnification of the image or even to arrange for a variable magnification.

In such cases the lenses must be arranged to give an erect image, or mirrors or prisms employed to erect the image. An example of a periscope of this type is shown in Fig. 2, where the mirrors are replaced by reflecting prisms, and the prisms erect the image in much the same way as the prisms of a prism binocular.

This arrangement is very suitable for a large magnification, but for larger fields the prism is unsuitable, unless it be silvered, and it is preferable to erect the image by means of lenses.

When longer tubes are used or larger fields are required, the design should approximate to that used in the submarine periscope.

This optical system has been steadily developed since its first introduction by Sir Howard Grubb in 1901.

The system consists of two periscopes, of which one is reversed, so that the image would be reduced in size, while the other magnifies this image, so that the final image is of the same size as the object, or is magnified one and a quarter or one and a half times. (As a very large angular field of view is required in these periscopes, the beam reflected into the tube must cover a large angle, and would soon fall on the sides of the tube; the reversed telescope, however, reduces the angle of the beam, and so enables it to proceed far enough down the tube to be received by the second telescope, and so transmitted to the eye.)

In modern submarines the tube has a length of from 16 to 24 feet, the diameter is from 6 to 9 inches, while the field of view is about 65 degrees. In order that objects shall look their real size, it is necessary to give a magnification of one and a quarter to one and a half.

Fig. 3 gives an illustration of a periscope in which three telescope systems are employed. The drawing is made from information published by Messrs. Goerz[1] of Berlin, and relates to periscopes made by them. It is, of course, undesirable to give any details of English periscopes at the present time.

An outer tube has a spherical glass cover. In the inner tube is the optical system, which can be rotated to face in any required direction; the eye piece, however, remains fixed.

The optical system, which follows in its general principles Sir Howard Grubb's original design, consists of:

(1) A reversed telescope, giving a reduction of about one quarter;

(2) A telescope, giving a magnification of about two;

(3) An erecting prism which can be rotated so that the image given by the system is correctly oriented;

(4) A telescope giving a magnification of about three.

This telescope includes a fixed eye piece and prism, so arranged that the observer looks horizontally at the object. At the focus of the eye piece are placed a scale and pointer to show the bearing of the object sighted, and a ruling to allow the distance to be estimated when the size of the object is known.

By the aid of a subsidiary system, special parts of the field can be further magnified to allow of objects being examined in more detail.

The continued use of the periscope is very trying to the eye, so that devices have been used to throw the image on to a ground glass screen. The ordinary eye piece and ground glass systems are made interchangeable, so that the observer can readily pass from one to the other; he may observe with the ground glass in the ordinary way, but examine special objects with the ordinary eye piece.

The field of view of the periscope is still limited, and various attempts to overcome this difficulty have been made. More than one periscope can be used and the images combined to form a complete image. A recent improvement consists in the use of a ring reflector

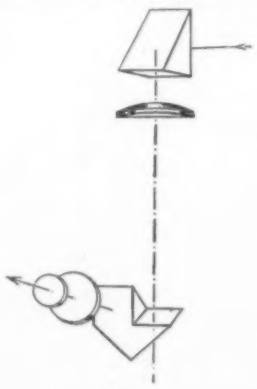


Fig. 2.

which enables a view of the whole horizon to be obtained at once. The image formed by the ring system is much distorted, but when any object is picked up it can be examined by means of the ordinary system. These two optical systems are combined in one instrument, so that the two images are seen in the one field, the image formed by the ring system surrounding the other.

But these ring periscopes are still far from perfect, their distortion making it very difficult to identify objects; and this difficulty, though not so pronounced, occurs with the ordinary periscope. The point of view from which the surface of the sea and surrounding objects are seen is one to which the eye is not generally accustomed. The conditions of lighting, too, render it difficult to distinguish objects, especially when there is mist or spray, so that the effective use of a periscope requires considerable skill and training.

Trench periscopes may be obtained from most opticians, and the following are a few typical forms:

The Hampson, wooden stake carrying two mirrors; price 7s. 6d.

The Adams, jointed rod; price 10s. 6d.

The Stanley; the support is in the form of lazy tongs, and is of a light alloy; price 25s.

These open-mirror types are light, portable, with good field, but the mirrors are not protected from rain, and the useful field is surrounded by bright sky.

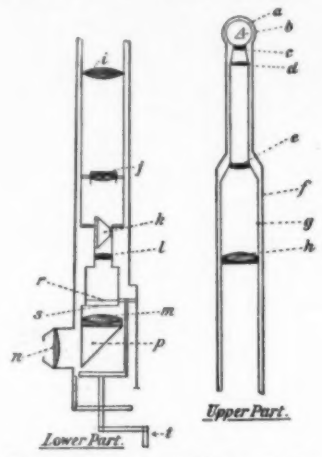


FIG. 3.—*a*, Glass cover; *b*, prism; *c*, *d*, and *e*, lenses of reversed telescope: *f*, outer tube; *g*, inner tube; *h*, *i*, and *j*, lenses of second telescope; *k*, reversing prism; *l*, *m*, and *n*, lenses of third telescope; *p*, prism; *r* and *s*, pointer and scale; *t*, rotating mechanism.

Tube types are made by Messrs. Negretti and Zambra, Dixey, The Periscope Company, and many others; prices from 8s. 6d. to 15s., depending on the metal tube used. In these types the field is rather limited.

Messrs. Charles Baker & Co. supply a type with large mirrors, which can be satisfactorily used with both barrels of a binocular. In spite of the large mirrors, the type is very portable; price 30s.

Many makers supply types in which the optical system is incorporated with the periscope, and the prices of these range from 28s. to 6l. 10s., according to the type of optical system used.

Battery-Operated Locomotive Headlights

IT is rather notable that the Southern Pacific road is using battery operated lights on its locomotives. The battery outfit is a 300 ampere-hour lead cell storage battery that is carried on top of the boiler, from which it is removed at the end of each trip for recharging by a special crane. The headlight takes 13 amperes at 6 volts, and the battery will operate this, together with three cab lights and two "blizzard" lights, for thirteen hours. For the headlight 140 candle-power nitrogen-filled tungsten lamps are used in the old standard reflectors.

Ozone Sterilizing Plant

A GOOD example of the Otto ozone sterilizing process by electric apparatus is seen in the plant at Sables-d'Olonne, France, one of the well-known Atlantic Coast watering places. The water is first put through sand filters in order to clarify it, and then goes to the ozone plant. A producer gas engine and dynamo furnishes the current for ozone apparatus and for motors. From the main well electric motor pumps take up the water and send it into the ozone sterilizing tank. The water then flows into a cistern from whence other electric pump groups deliver it to the town piping. The present plant contains apparatus for 6,000 cubic feet an hour total, and is laid out in two identical groups of 3,000 cubic feet each. A separate dynamo group is provided for each group, so that they are independent. Two electric pumps serve to supply the filter basins from the source, and another pair of pumps of 3,000 cubic feet output each handle the water between basins and sterilizer. For the offtake of the sterilized water there are also two centrifugal pumps of the same type, making six pump groups in all for the plant. We should say that since the installation of a similar plant at Nice the mortality fell from 40 per 1,000 inhabitants annually to 15 per 1,000, which is an excellent result.

* S. D. Chalmers, in *Nature*.

[1] Dr. Weichert, Jahrbuch der Schiffsbautechnischen Gesellschaft, 1914.

The Romance of Motion Pictures*

A Scientific Toy that has Grown to be a Great Commercial Factor

By C. Francis Jenkins

WHERE the idea of motion pictures originated I do not know. But a hundred years before Christ, Lucretius strangely wrote his friend, thus:

"Do not thou moreover wonder that the images appear to move, and appear in one order and time their legs and arms to use; for one disappears and instead of it appears another arranged in another way, and thus seems each gesture to change. For you must understand that this takes place in the quickest time," which is an exact description of the motion picture of to-day.

If this is really what he meant, then it took two thousand years to get a suitable picture ribbon and a perfect machine to handle it, and ten years more to put the business on a paying basis. When we had motion pictures at the Atlanta Cotton States Exposition, in 1895, we were not able to convince the people there was anything inside worth looking at. So we threw the doors wide open, inviting the weary sightseers to come in and sit down for a rest, and after the exhibition explained that anyone who wished to contribute twenty-five cents for the exhibition he had seen of this wonderful new invention, might leave it at the box office going out, and we should be duly grateful therefor. Nor was our confidence in the American's love of fair play misplaced, for the money began to roll into the box office.

The year before, in Washington, I found it just as difficult to make personal friends understand in advance what these pictures were. And again, in the winter of 1894-1895, in an exhibition before the Franklin Institute of Philadelphia, a gentleman, in seconding a motion which had been proposed by someone that the society award the Elliott-Cresson Medal for this invention, said, that while he heartily seconded the motion, he would like to inquire whether Mr. Jenkins could tell them of any way by which the device could be made commercially profitable. I had to admit that I could not, for I was only an inventor, and an inventor rarely knows how to make money for himself.

And so matters drifted along some eight or ten years until a venturesome spirit opened a little five-cent theater in a vacant store on Fourteenth Street, near Broadway, in New York city. He made arrangements with cameramen which guaranteed him a new picture every day, and this was the beginning of the motion-picture theater industry and a film exchange system which has continued until now.

So now we have a device for dramatic representation which gives us every form of entertainment known to man since the beginning of time. We present the story teller in a pantomime far more effective than mere words alone; we show every form of spectacular reproduction in a splendor never dreamed of by a Cæsar; we present every human emotion known to exist in a realism and costume true to nature; we multiply the magic lantern a thousand-fold in every reel; we bring every distant country, every strange people, every quaint custom, every new and wonderful invention, every scientific discovery, all this we bring to the stay-at-homes, and the humble nickel pays the fiddler.

Of the early workers in motion pictures Prof. Muybridge obtained an analysis of motion that caused artists to change their accepted notions. His animal locomotion studies have become classics. But little later Prof. Marie used motion pictures in certain scientific work he was doing, in Paris. And still later Anchutz, exhibiting motion pictures at the World's Fair, Chicago, 1893, with a box into which one looked to see small pictures. However, these gentlemen all contented themselves with analysis of motion, mainly. Where they tried synthesis the resultant pictures were but small. It fell to my lot to take the one step which made these little pictures large and unlocked the flood gates of a business amounting last year to near $800,000,000.

Motion pictures not only show strange, truthful things, but will entertain you with unreal things with such a realistic semblance of truth that you grip your chair in excitement. You follow with the hero through all the stages of love and hate and passion, and settle down with a sigh of relief when the crisis is past. It may be you see the professor walking in the street, head bowed in abstract thought, knocked down by a ten-ton road roller and rolled out as thin as a piece of paper, but getting up again goes on his way all unconcerned; or perhaps you see the mislaid mittens of a pickpocket crawl stealthily down from their shelf, cross the room, climb up the chair leg, up the man's back, reach quietly under his chin and steal the diamond from his tie? And you see these mittens caught in the act and locked in a solid box, go groping around inside searching every nook and corner for an avenue of escape, only to stop at the lock, and slowly unraveling, steal through the key-hole and deposit themselves in a pile of loose yarn on the table, and immediately thereafter patiently reknit themselves into a pair of mittens again.

The moving picture is rapidly coming to be recognized by the educator as of great value in his work. The legislatures of three States have passed bills and appropriated money providing for motion pictures in their schools, while the law-making bodies of several other States are being urged to provide those pictures as an aid in instruction, it being conceded that picture education was our first and is the quickest and the most lasting. Education is simply the forming of mental pictures, but these pictures should be alike on every brain. If a class of a hundred students learn an oral lesson a hundred mental pictures are formed, but they are probably all different. If, however, the lesson is taught by motion pictures the hundred mental impressions are all alike. And these picture lessons are brought from every nook and corner of the earth, without translation, for the motion pictures speak a universal language.

Perhaps it is not known to all of you that this picture ribbon is the only unit that is standard in every country. Railway gages, for example, vary in different countries, units of value, volume, weight and of length differ, even the color of the people vary in every clime, but the motion-picture film is the same the world over. The usual unit length is 1,000 feet, known as a reel.

And now a word about the mechanism by which these results are attained. It may seem perhaps unnecessary at this late day to say that a motion picture is the synthesis of a long series of separate pictures placed end to end on a ribbon, and that these pictures are projected by means of a modified magic-lantern onto a canvas or screen, sixteen pictures per second. Each little picture is brought into the focus of the projecting lens intermittently, and it is this intermittent movement of the film at the picture aperture of the machine which is the vital feature of the mechanism. The device by which this is accomplished is an enlargement of the Geneva stop, found in many watches, to prevent winding the spring too tight.

Upon the accuracy of the locking portion of the driven member of the Geneva gears referred to depends the steadiness of the picture on the canvas, for the film must be started and stopped with microscopic exactness nearly one thousand times per minute.

The other of the two essentials of acceptable motion pictures to-day is the absence of scintillation or "flicker," as it is known in the art, which some years ago so affected one's eyes, often the cause of serious headaches. It is the alternation of the light and darkness caused by the passing shutter blade which causes the flicker, and this occurring sixteen times per second was painfully conspicuous. Later someone suggested cutting the light period twice more for each picture by putting on two more blades, resulting in forty-eight flickers per second instead of the original sixteen, and because the eye does not readily perceive forty-eight alternations of light and darkness per second flicker is practically eliminated.

The machine which I shall use to-night avoids the flicker, but in another way. It depends on the fact that it takes a perceptible time for the retina to recover sensitiveness after the impress of a strong light. So, if one impresses the picture on the eye for a sufficiently long time, relatively, one does not notice the changing of the picture, and little or no flicker is observable. This enables one to secure brilliantly lighted pictures with a small amount of current, for the picture is impressed on the eye continuously, except for the 1/160th of a second employed to bring each little picture into the projection aperture of the machine.

These two devices, then—the Geneva gear and a proper shutter—are the obscure essentials of the modern picture-projecting machine for producing a steady, flickerless picture, while all the others elements are simply matters of convenience or of fire insurance underwriters' requirements.

Two changes are rapidly nearing adoption to overcome conditions which have heretofore handicapped the owner of a photo-play house. First, within a very short time he will be able to choose a programme according to his own conception of the tastes and wishes of his patrons; and second, the price of admission will be higher and tickets will be sold which represent a particular seat in the house just as they are now sold for the ordinary talking theater.

This change of method logically results, and to show the reason for this trend in the art one might take, as an example, any one of a dozen picture-producing companies with studios located in southern California, where photographic light is practically uniform the year round. Here are hundreds of thousands of acres under purchase or lease, and above a million dollars' worth of wild animals, in great variety, handled by skilled animal trainers, the whole used as playground and accessories for the making of motion pictures which will entertain and instruct. At least $15,000,000 are invested in southern California in the making of pictures. These and other playgrounds are being used to produce pictures of a higher class and quality. The cost of each such picture runs into large figures, consequently film-rentals are higher, and a five-cent admission is no longer as profitable as formerly.

Some five or six years ago I happened to be in a studio in New York when a little girl and her friends came in from the street to watch the making of a motion picture and perhaps with the hope that they might be requisitioned for extras in the play. The play being photographed portrayed an old musician who had been unsuccessful in his efforts to have a piece of music he had written produced and had at last been reduced to the necessity of playing the violin on the street corners for such pennies as might be tossed him. Between times he had taught the little grandson to play the violin. And so the plot was laid. A boy was needed for the part. The director, glancing at the row of children against the wall, instantly picked out the particular little girl I have mentioned. Calling her to him, he asked: "Will your mother let your hair be cut?" The little girl thought so, but would go and ask, and away she ran, presently returning with the required permission; and so to the barbers they sent the lassie, while a messenger was dispatched to buy a boy's suit. I distinctly remember seeing the director tearing the pockets and slashing the coat with his knife to make a new suit look like an old one. In the opening scene the lad "rustles" the few dishes and pans in supper anticipation until presently the old man comes in and drops wearily into a chair. The little fellow runs to him and strokes his forehead and hair until he falls asleep under the gentle touch. Then he slips quietly out of the room with the violin and bow under his arm. In the next scene he bursts into the room with his hat full of money, and waking the old man shows him their wonderful luck. That little girl was Mary Pickford. She received $5 for her day's work; but what was more important, it was seen that she possessed in exceptional degree those rare characteristics so necessary in the picture business—a good photographic face, the gift of feeling the part played, and the ability to do it in pantomime. Her salary to-day is $2,000 a week whether she works or not, and she is known to every motion-picture "fan" in the whole world. Of course, not all players get any such salaries, but it is this very example of erstwhile unknown people reaching up to big pay envelopes that has caused the almost wholesale exodus of mount into the billions; and surely a business which theaters, from the "divine Sarah" to the most lowly player. But I assure you that many of them will be disappointed, for acting before a camera is a very different thing from acting before the footlights. The best players for motion pictures are those who have grown up with the business. They don't have to unlearn anything.

Among the producers the same story might be told. I can name among my own personal acquaintances at least a dozen millionaires who four to eight years ago had practically nothing. But do not for a moment think that money is so easily made in motion pictures that it requires no effort of judgment, for while an opportunity is there, it takes judgment in this business just as surely as it takes judgment in any other business.

So this is the industry which has grown up since the little exhibition which I gave in 1893 in the first club rooms of the Capital Camera Club, an industry which has grown until the property interests represented mount into the billions, and surely a business which gives so much pleasure to more than ten million of people daily cannot be wholly bad.

* Address delivered before the University Club, Washington, D. C., April 24th, 1915.

The Measurement of Distances in War*

Ingenious Modern Methods and Instruments Now Used

In war the direct measurement of the distance of the enemy's position is out of the question, and measurement by triangulation is practicable only in fortified places. In all other cases, until recently, distances could only be guessed. Many attempts have been made

Fig. 11.—The steoroscopic telemeter in use.

to devise accurate methods of measurement, but all of the older methods are too imperfect or too laborious for practical use.

In 1899 Pulfrich invented for the Zeiss Company a remarkably accurate and convenient instrument which has since rendered very valuable service.

The Zeiss stereoscopic telemeter is based on the principle of stereoscopic or binocular vision. A good eye can distinguish objects seen under a visual angle of 30 seconds, which is equal to the angle between the apparent directions in which an object about 1,500 feet away is seen by the right and left eyes. The stereoscopic effect, therefore, is appreciable at this distance, which may be called the depth of the stereoscopic field. This depth may be increased either by using a binocular field

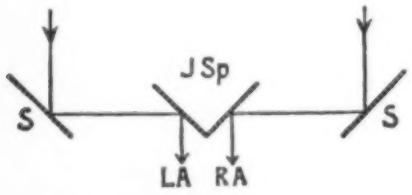


Fig. 1.—Helmholtz telestereoscope.

LA, left eye; *RA*, right eye; *JSp*, inner mirrors; *SS*, outer mirrors.

glass or by artificially increasing the effective interocular distance. The second method is adopted in the telestereoscope of Helmholtz, which consists essentially of two pairs of inclined mirrors, arranged in the manner indicated by Fig. 1. The large lateral mirrors *SS* are parallel respectively to the two small central mirrors *JSp*, which are rigidly connected at right angles to each other. (They may be adjacent faces of a right angle prism.) Each eye sees the landscape by double reflection from the large and small mirror on one side, and the effect is the same as if the eyes were moved outward to the positions of the lateral mirrors *SS*. If the distance between these mirrors is six times as great as the real interocular distance (2.6 inches), the effective interocular distance and the stereoscopic effect are increased six-fold and, as all dimensions are estimated in relation to the interocular distance, the landscape appears six times smaller and six times nearer than it is in reality. The same effect can be produced by viewing the scene directly with the left eye, and holding before the right eye a small mirror, inclined 45 degrees to the line of sight, which reflects into the eye the image of the scene formed by a larger parallel mirror placed 15 inches to the right.

If a binocular field glass is interposed between the telestereoscope and the eyes, the scene is again apparently brought nearer, but without reduction of scale, to a degree proportional to the power of the field glass. This combination of field glasses with the telestereoscope is realized in the Zeiss relief telescope (Fig. 2). The visual rays are reflected by prisms at each end of the telescopes, in the manner indicated in Fig. 3. If the magnifying power of the telescopes is 12 and their outer ends are separated by 10 times the real interocular distance, the stereoscopic effect is $12 \times 10 = 120$ times greater than it is with the naked eyes. The depth of the stereoscopic field, therefore, becomes $120 \times 1{,}500 = 180{,}000$ feet, or 34 miles. The depth can be increased to more than 100 miles by employing longer and more powerful telescopes.

The telescopes are hinged at their inner ends and the stereoscopic effect can be diminished by bringing them together (Fig. 4). When they are folded as closely as possible the stereoscopic effect is least, but in this position they are very useful in many cases, for the observer can keep his head under cover, allowing only the ends of the tubes to protrude.

A similar, though smaller, stereoscopic effect is produced by the Abbe-Zeiss prismatic field glass (Fig. 5), in which the objectives are about twice as far apart as the eyes, so that, with a magnifying power of 10, the depth of the stereoscopic field is $10 \times 2 \times 1{,}500 = 30{,}000$ feet, or nearly six miles.

In both of these instruments two slightly different images of the scene are produced in the focal plane of the objectives and are viewed through the eye-pieces. The stereoscopic impression of distance is due to the fact that the two images of a near point are less widely separated than the images of a distant point. If two marks, m_1 and m_2, are placed in the axes of the eye-pieces, just in front of the focal plane (Fig. 6), they will appear as a single mark at infinite distance. If the mark m_2 is then moved to the position m'_2 or m''_2, it will combine with m_1 to produce the appearance of a mark at the distant point m' or the nearer point m''.

In this manner the mark can be brought into apparent coincidence with a church steeple or other object *P*. The distance of this object can be calculated from the amount by which the movable mark has been displaced from its zero position m_2.

Instruments with movable marks have been constructed and employed in practice, but they require a separate calculation for each observation. It is far more convenient to place in the focal plane a fixed scale, so graduated that each interval corresponds to a distance of 100 meters. This produces in the field of the telescope a scale of measurement that can be applied to any part of the landscape. The operation of this device is illustrated in Fig. 7. The marks m'_1 and m'_2, engraved on the glass scale, produce the appearance of a single mark m', at a distance of 500 meters, for example. Two other scale marks produce the stereoscopic image m'', at a distance of 600 meters, and so on. Hence, a church steeple *P* that appears midway between m'' and m''' is 650 meters away. Usually the scale is made in three inclined sections and the rows of marks appear to traverse the scene in zigzag receding lines, as will appear in the most striking manner if Fig. 8 is viewed through a stereoscope, or if each side is viewed with the corresponding eye, a large card being held vertically between the eyes, if necessary.

Fig. 8.—A view through the stereoscopic telemeter.

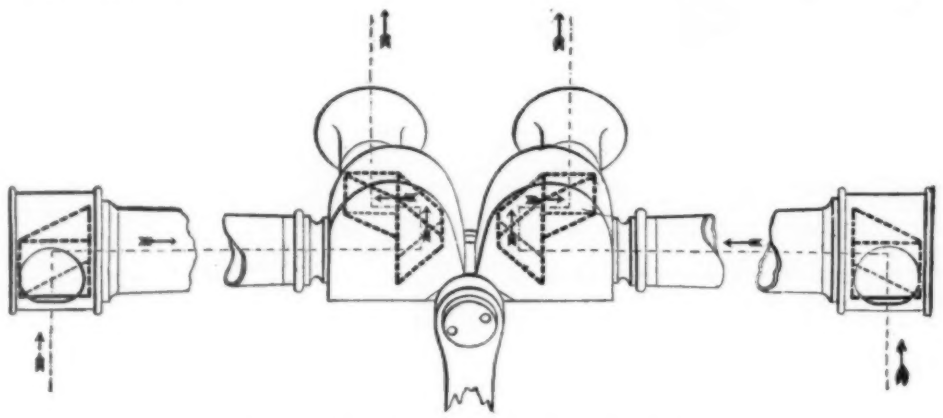


Fig. 3.—Path of rays in Zeiss relief telescope.

The Zeiss stereoscopic telemeter, in which this measuring device is employed, is shown in Fig. 9, and the path of the visual rays in the instrument in indicated in Fig. 10, while Fig. 11 illustrates the method of using the telemeter without the aid of a stand.

The instrument is made in three models, having the following dimensions:

Model.	Length.	Magnify'g Power.	Stereoscopic Depth.	Range.
I	51 cm.	8	28 km.	75 to 3,000 m.
II	87 cm.	14	84 km.	300 to 5,000 m.
III	144 cm.	23	228 km.	700 to 10,000 m.

For the same distance, more accurate results are obtained with large than with small models. The tube is too stiff to bend appreciably and an envelope of felt protects it from unequal heating, which might produce curvature. The eye-pieces can be adjusted to the in-

* Abstract of Prof. Keller's article in *Die Umschau*. Translated for the SCIENTIFIC AMERICAN SUPPLEMENT.

Fig. 2.—Zeiss relief telescope.

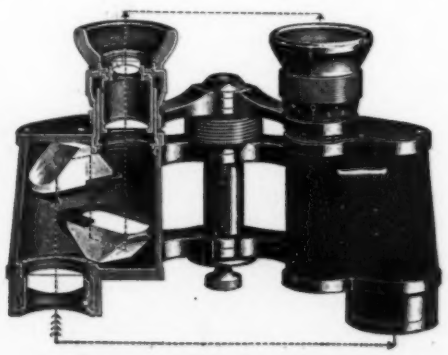


Fig. 5.—Zeiss prismatic field glass.

terocular distance of the observer, and the scale can be illuminated for use at night. The heights of objects can be inferred from the marks already described, which rise and diminish in size as they recede, but the instrument also contains a vertical scale for more precise measurement of heights.

The stereoscopic telemeter is especially valuable for

Fig. 4.—Zeiss relief telescope folded.

measuring the distance of a moving object and in disturbed conditions of the atmosphere, when it is impossible to use a theodolite, and it is indispensable for measuring the elevation of airships and aeroplanes. The instrument, furthermore, gives a simultaneous comprehensive view of the distances of all points in sight,

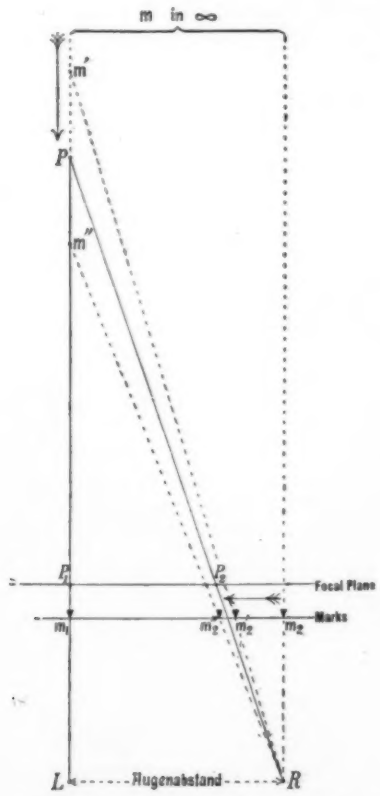


Fig. 6.—Principle of movable marks.
L, left eye; *R*, right eye.

while the theodolite requires repeated settings and tedious calculations in order to deduce the distance of a single point. The stereoscopic telemeter, in short, puts the observer in possession of an exact, living model of the field of action and also of a convenient scale for measuring all distances in every direction, even the caliber of the mouths of the enemy's cannon.

Fuel Oil*

THE use of oil in one form or another as fuel for generating power or for domestic heating should be considered under several conditions: First, where oil is the most efficient source of heat and power because of the absence or inadequate supply of cheaper fuel. This is the condition on the entire Pacific slope. Second, where the use of oil as fuel represents a means of disposing of excess accumulation of crude oil, residues, or distillates, for which no market is at hand. This condition frequently prevails in the newer fields of the United States; it always represents a means of disposal by the refineries of undesirable products which would otherwise go to waste. There is a third condition of use of crude oil or its products as fuel which is in a radically different class. This is its application to the generation of power by making steam or in internal combustion engines in the Navy and the merchant marine. This use is not so strictly limited by the price.

The production of a sudden flood of new oil in any part of the world naturally carries with it the utilization of more or less of this oil for fuel when the price per barrel goes below the limit of competition with coal. Thus at present in Wyoming, although that State contains adequate supplies of coal, use is made of the otherwise unsalable products from the Casper refineries for locomotive service over long distances in that State. This use must naturally increase from the fact that the production of oil in Wyoming is extending faster than any possible adequate market for the heavier products.

Crude oil seldom remains cheap for a very long period, and therefore the supply for railroad use and for other fuel purposes is so unreliable that crude oil as a fuel has lost favor very rapidly, and recourse is eventually made to those products from the crude, which happen in the particular oil under consideration to more than supply the demand for those particular products.

A short time ago the separation of a given crude oil into marketable products was strictly limited by the quantity of these different products naturally occurring in the crude oil. But more advance methods of refining have lately included the ability to break up the less salable products in crude oil, and thus increase to a very great extent the yields of those products which are most salable.

An interesting example of this is found in California, where the oils obtained a few years ago contained only small percentages of gasoline and kerosene, so that there was a very large quantity of heavier products from the oil, all of which happened to find a good market as fuel. At first, in order to make up the deficit in gasoline and kerosene, gasoline and light crude oils containing much gasoline were imported from Borneo and Sumatra; then recourse was made to extracting gasoline from such natural gas as occurs in association with oil and contains considerable quantities of gasoline vapor. Within the last two years, following this extraction of gasoline from natural gas, the supply of gasoline has also been augmented by cracking the heavy crude oils under pressure, with the resulting production of "motor spirit."

Within the last two years also, a more significant change has occurred. The oils recently produced, especially those from considerable depth, have shown a much greater content of gasoline and kerosene—so much so, indeed, that the effort to produce an adequate supply of gasoline has been overdone. This material, so much in demand in the Eastern United States for automobile and other internal combustion engines, has glutted the market of the Pacific coast, with consequently greatly decreased prices.

It is evident that the ability of the refineries to furnish, from all kinds of crude oils, those products which are in greatest demand has enormously increased within the last few years. As a result there is much less of any waste product to be thrown into the waste tanks and sacrificed under the general term of fuel oil. The prices of this material rose significantly in all parts of the eastern fields. Low prices for fuel oil in the future will depend chiefly upon the production of oil of all grades, in such quantity that much of it can only find market as fuel.

Within the last few months, however, the tendency toward cheaper fuel oil has increased because of the producing of low-grade crude oils in larger quantity in the Gulf field of Louisiana and Texas—that is, at Vinton and Edgerly in Louisiana, in Orange County in Texas, and also at greater depth in the old fields of Sour Lake, Saratoga, and Batson, in Texas.

The mid-Continent fields are forcing the heavier oils of the Gulf region to find a market elsewhere, chiefly as fuel. These Gulf oils yield good lubricants, but only a small proportion of the supply can find a market for that limited use. Further, the large fleet of tank steamers lately built enables Mexican oils to invade the eastern coast of the United States. This makes it probable that a large use of fuel oil may become a feature in manufacturing enterprises of the east coast region, and that while this use is being developed careful study will be given to modern methods of burning oils in internal combustion engines. It should be borne in mind, however, that if this substitution of coal by oil receives very great favor the movement would easily

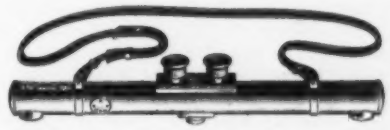


Fig. 9.—The Zeiss stereoscopic telemeter.

overtax the limitations of all the tank steamers in the trade. In the meantime, the advantages of fuel oil for marine engines are so great that the navies of the world will demand it independent of its price, and the merchant marine will be obliged to give this matter extremely careful consideration. Should an outlet for fuel oils really be opened by one large transatlantic steamship line, the effect upon the price of fuel oil would be marked.

* From the report of the United States Geological Survey on the Production of Petroleum in 1913.

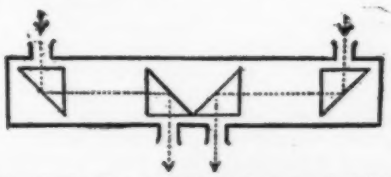


Fig. 10.—Path of rays in Zeiss stereoscopic telemeter.

Harvest Forecasts for 1915

THE Board of Agriculture and Fisheries have received the following information from the International Agricultural Institute:

Reports have been received on the sowing and the condition of winter cereal crops in the Northern Hemisphere.

Regarding the extent of crops, there is an increase in the area sown in comparison with the 1914 area of wheat in Italy (12,350,000 acres, an increase of 5 per cent), in Canada (1,293,000 acres, an increase of 33

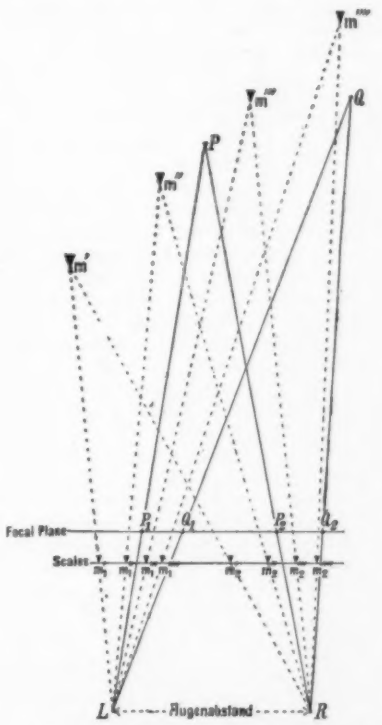


Fig. 7.—Principle of telemeter scale.

per cent), in the United States (41,246,000 acres, an increase of 11 per cent), and in India (28,681,000 acres, an increase of 22 per cent). For the present crop conditions are not generally stated to be abnormal.

For wheat the 1914-15 harvest forecasts are available for Argentina, Chile, and Australia, the total present crop in all these countries being estimated at 131,743,000 hundredweights, compared with 123,054,000 hundredweights in 1913-14. The excellent yields of Argentine and Chile largely compensate for the reduced crop in Australia.—*The London Daily Telegraph.*

Atoms and Ions—IV*

A Comprehensive Discussion Especially as Related to Gases

By Sir J. J. Thomson, O.M., F.R.S.

Continued from SCIENTIFIC AMERICAN SUPPLEMENT No. 2054, Page 311, May 15, 1915

IN opening the fourth of his lectures, the lecturer said that he wished to draw attention to cases of ionization produced by heating various salts. The problems here involved had two aspects, according as the electricity was liberated from the solid salt itself or from the vapor occupying the space immediately above it. It was necessary that these two aspects should be kept apart and considered separately if clear ideas as to the nature of the ionization were to be attained. When certain salts were heated there was, he proceeded, a marked production of electricity, the character of which was found to depend a great deal on the nature of the salt. Where the electricity was liberated from the solid salt there was in some cases a marked excess of positive electricity, while with other salts it was the negative electricity which was in excess.

Taking a little aluminium phosphate and raising its temperature by means of an electric heater, the lecturer showed that when a plate connected to an electroscope was brought over the hot salt, the electroscope was rapidly discharged when its own charge was negative, but that the leakage was insignificant when the electroscope was positively charged. When aluminium phosphate was heated, he proceeded, positive electricity was produced in great excess, while with other salts similarly treated it was the negative electricity that was in excess. Whether the one result or the other was attained depended upon the chemical nature of the salt, and he had found an interesting connection between the character of the charge liberated by heating and that liberated when the salt was crushed in an agate mortar. Most salts, he said, get electrified when carefully powdered, and the sign of this electrification was the same as that of the electrification produced when the salt was raised to a high temperature. It would seem, therefore, as if in both cases the electricity was due to the tearing off from the salt of a surface layer of electricity spread over it. If this layer was removed to some extent by powdering or by heating, we should get exactly the effects observed.

It was important in such cases to know what was the carrier of the electricity produced. The usual method of measuring the mass of the carriers was not readily applicable in experiments of this kind, as the high temperature would affect the photographic plate or phosphorescent screen used. Another plan was therefore adopted. A plate connected to an electroscope was placed parallel to the plate supporting the heated salt, and between the two plates and parallel to them a strong magnetic field was established. If the field were destroyed, every electrified particle from the salt would reach the opposing plate and help to discharge an electroscope connected therewith. On re-establishing the field, however, the magnetic force would curl round the paths of these particles into circles, and the stronger the field the sharper would be the curvature of the trajectories. Hence by making the field sufficiently strong, the orbits of the particles would be bent round so much that none of them reached the opposing plate, but fell back on to the salt below. Hence by varying the magnetic field, it was possible to pass from a state in which all the particles reached the opposing plate to one in which none of them did; and the transition was a pretty sharp one. Knowing the distance at which the particles just failed to reach the plate, the ratio $\frac{e}{m}$ could be determined by means of the equation:

$$d = \frac{2X}{H^2} \cdot \frac{e}{m}$$

where d denoted the distance between the plates, X the electric force urging the particles from one plate to the other, and H denoted the magnetic field.

From experiments based on this principle, it had been found that when either sodium or potassium was contained in the salt heated, the carriers of positive electricity were nearly always atoms of one or other of these metals. Indeed, Prof. Richardson had gone so far as to maintain that atoms of alkaline metals were the carriers in all cases, whether the salts were or were not supposed to contain sodium, the alkali being present, in fact, as an impurity.

The speaker had himself made experiments on the nature of the carriers produced when platinum was heated, and found for them, in this case, an atomic weight of 26, which fitted in very well with the supposition that the carriers were molecules of carbon monoxide. He believed that in the majority of cases it was the gases absorbed on the surface of the bodies under investigation which provided the carriers, and CO was always given off when metals were heated in vacuum, and his own experiments supported the view that in such cases the carriers were molecules of this gas. If the carriers were sodium atoms, the atomic weight found should have been 23 instead of the 26 actually observed. Nevertheless, in cases in which the salts under investigation actually did contain sodium, Richardson had got very abundant electrification, showing that sodium and potassium were very well adapted to serve as carriers of positive electricity, but the lecturer could not accept the view that the carriers were in all cases atoms of these metals.

He would next consider cases in which the electrification arose from the vapor of the salt, and could be detected even if this vapor were sucked off into another vessel, and tested there. This phenomenon had been specially studied by Schmidt and Kalandyk, the latter working in the Cavendish laboratory. The vapors examined were those of cadmium iodide, zinc iodide, and zinc bromide; these vapors showed a high conductivity, and there must therefore have been a separation of the positive and negative charges in the molecule. By determining the way in which this conductivity varied with the temperature, it was possible to calculate the work required to separate the charges, and in this way Kalandyk had found for cadmium iodide the value 1.79 volts, which, it would be seen, was very much less than the 5 volts required to ionize mercury vapor. This was an interesting instance of ionization being effected with a very small expenditure of energy, and apparently the ionization of the vapor of this salt might be considered to be a genuine ionization of a gas, effected with an energy expenditure of less than 5 volts. There was, however, one suspicious point in the matter—viz., that the ionization was greatly increased if a little water vapor were present. There were other cases in which the presence of water vapor had a marked effect on the production of electricity. Thus, if sulphate of quinine were heated to about 180 deg., and allowed to cool, it gave out electricity, if the cooling took place in such conditions that water vapor could be absorbed, but none if water vapor were excluded from the cooling salt. In all these phenomena we found throughout the enormous influence exerted by the presence of difference substances. When the greatest precautions were taken to purify the bodies under investigation it was found that in many cases the effect diminished to a mere fraction of its original value. For example, the purer aluminium phosphate was the less was the electricity produced on heating it. Again, Pring and Parker had found that by taking extraordinary care to get rid of the gases occluded by carbon, the ionization produced by heat was diminished to less than one millionth of its original value.

All through these observations the importance of mixtures was, in fact, very evident, and in all these cases we were perhaps in the presence of the oldest type of ionization known—viz., the electrification produced by friction of dissimilar bodies. This was the original method of producing electricity, and as yet but little definite was known about it.

The hypothesis which for the present fitted in best with the facts observed was that when two different molecules came sufficiently close to each other, there was a tendency for negative electricity to pass from one to the other. In general, however, sufficient energy was not available to separate the positive and negative charges from each other to any appreciable extent; but the bond between the two had, as it were, been cracked, and the operation could then be completed by brute force, applied either mechanically or by heat treatment. Volta was not able to show the electricity produced by contact of copper and zinc, but on pulling them apart again—an operation requiring the expenditure of work—the effect produced was large enough to affect even his comparatively insensitive instruments. On this view, the putting of two different molecules together served as a delicate tool capable of starting the joint between the charges, putting them into a state in which the separation could be completed by "unskilled labor" in the shape of friction or heat. This viewpoint made obvious the great effect on electrification to be expected from the presence of impurities in the bodies under examination. Thus the hydrogen occluded in charcoal coming into contact with the molecules of carbon produced a difference of electrical condition, and then a supply of heat furnished the energy necessary to separate the positive and negative charges to an appreciable extent.

Having considered so far what different agents produced ionization, the lecturer said he would next discuss a case in which electrification was observed, but of which the origin was most obscure. Ordinarily air was regarded as devoid of conductivity, being a typical insulator. Nevertheless, very delicate experiments had shown that ordinary air did possess a certain amount of electricity, though not very much. To demonstrate this the lecturer sucked a large quantity of air through a tube, along the center of which was a wire connected to an electroscope, the wall being earthed. On setting the pump to work, the electroscope showed a very slight but continuous loss of charge, which stopped on stopping the pump. The conductivity which caused this loss of charge was, the lecturer said, in part due to the presence of radium or its emanation, which, in fact, was responsible for about half the conductivity found in the air of an ordinary room. If, however, the conductivity was measured of the air inside a box with very thick walls of lead, thus screening out any action of radium, some conductivity was still to be observed. Similarly, if the state of the air was measured in mid-ocean, near the center of a frozen lake, or in other places where the effects of radium were excluded, this residual conductivity was always perceptible. Measurements made nearly all over the world showed, moreover, that this residual conductivity was much the same everywhere, from Canada to near the South Pole. In amount it corresponded to the production of four ions per second per cubic centimeter of air. This might seem so small as to be ridiculous, and, in fact, the year's birth-rate of ions against the molecules of air was less than one in a million, but this residual conductivity was, nevertheless, one of the most interesting problems now under consideration.

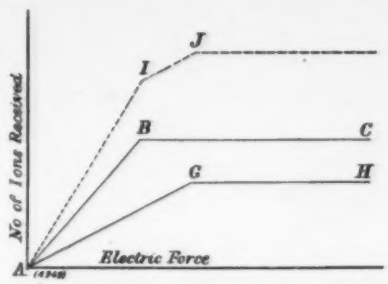
These four ions per cubic centimeter per second were produced whatever the region of the globe in which the experiment was made, and whatever the material of which the box was constructed, and this occurred with the walls so thick that no radiation of which we had as yet any experience could penetrate from the outside. How these ions were produced was the problem. It might be thought that they were caused by molecular collisions, since by the kinetic theory of gases particular particles might possess an abnormal energy, sufficient, perhaps, to liberate electricity on colliding. On this hypothesis, however, the rate of ionization should increase very rapidly with a rise of temperature, but apparently temperature changes had no appreciable effect. Throughout a range extending from 0 deg. Cent. to 180 deg. Cent. the number of ions produced was practically constant, whereas did they originate in a bombardment by exceptionally quick molecules, the rate of ionization should have been far more at 180 deg. Cent. than at 0 deg. Cent.

What the explanation might be was a matter of absorbing interest. The conductivity could not be due to a special radiation from the walls of the vessel, as the ions were produced at the same rate per cubic centimeter whatever the size of the vessel, although in small vessels the ratio of wall area to cubic content was greater than it was in large vessels. At present, indeed, the whole matter was a mystery. Perhaps the gas itself gave out something like Röntgen radiation, which was not affected by temperature changes, or possibly it might be due to some other gas or compound mixed with the air in very small quantities, which could be ionized at ordinary temperatures. At present, however, we had no light on the source of these four ions per cubic centimeter per second, which were generated in ordinary air, after all external influences were screened out. It would, the lecturer said, be very interesting to try how this residual conductivity varied with the nature of the gas, but so far as he knew no experiments had yet been made on this head.

In town air, or in other places where there was much dust, the ions produced were mostly absorbed by the dust, and the electricity was borne by these dust particles, and not by the molecules. Experimenting at Paris, Langevin had found that there were ten times as many ions caught by the dust as remained free as

*Reproduced from *Engineering*

molecules of air; while in the open country, where there were comparatively few dust particles, the electricity was much more mobile, being carried by molecules. A peculiarity found by Langevin was that there were no ions intermediate in size between molecules and great, heavy things like dust particles. Under a field of 1 volt per centimeter "molecular" ions would move at the rate of 1 centimeter per second, while the "dust" ions in the same field would only move at the rate of 1/1,000 millimeter per second. Langevin had used a very ingenious method of determining the type of particle present. Passing a stream of air through a tube across which an electric field was established, the particles were impelled toward the wall. With a certain strength of field all the particles of a particular size within a given distance from the wall would be drawn down and captured before they escaped from the tube. By increasing the field, the thickness of the layer from which the



whole of the ions were removed would be increased, and, finally, a certain stage would be reached at which all the ions of that kind contained in the flowing stream would be removed. Up to this stage, assuming one kind of ion only to be present, the number captured would be proportional to the electric force, so that a graph between this force and the number of ions captured would have the form indicated in the annexed diagram by the *A B C*. At the point *B* the whole of the ions would have been taken out, and no further increase in the electric force would raise the number captured. There would thus be a sharp kink at the point *B*. If the ions had been of a more slowly moving kind, a flatter curve, such as represented by *A G H*, would be obtained, the kink at *G* denoting the point at which all these heavier ions had been captured. If, however, both kinds of ions were present in the air, the combined curve, having the two kinks *I J*, would be obtained. Each kink, in fact, denoted the existence of a different kind of ion, and Langevin's curve contained two kinds only, showing that only two types of ions were present, one being gaseous molecules, the other particles of dust.

(To be continued.)

How Much Albumen is Needed in Our Diet?*

Interesting Results of Some Extended Experiments

Prof. Max Rubner asserts that the quantity of albumen required to keep the human organism in balance varies with the character of the diet, because the albumens of foods differ in nutritive value, so greatly that a man requires 81 grammes of the albumen of bread for his daily needs, which are satisfied by 25 grammes of the albumen of meat. This statement is based on experiments in which men were fed on bread alone for three days. The minimum daily loss of nitrogen in the urine was 13 grammes, the quantity contained in 81 grammes of albumen. Hence Rubner concludes that 81 grammes of albumen must be assimilated daily; 81 grammes of digestible albumen correspond to 90 or 100 grammes of total albumen. The minimum ration, however, should be somewhat exceeded in a standard diet, and so Rubner approves Voit's old daily allowance of 118 grammes of albumen.

The statement that 81 grammes of albumen daily are required in a diet of bread alone has become a cornerstone of dietetic doctrine. As my earlier experiments with this diet had shown that the daily elimination of nitrogen could fall much below 13 grammes, I decided to investigate the question thoroughly. For this purpose two strong young men, 27 and 22 years old, were fed almost exclusively on bread, or on bread and fruit, for six months, from January to July, 1913. The experiment was divided into periods of about twelve days each. It began with three periods of a pure bread diet. In the first period the mean daily excretion of nitrogen was 9.9 grammes, the amount decreasing from 11.8 grammes on the first day to 8.8 grammes on the twelfth day. The mean daily intake of nitrogen in the food was only 9.6 grammes, so there was a mean daily loss of 0.3 gramme. In the second period the mean daily excretion was 7.6 grammes and the intake 8.1 grammes, showing a gain of 0.5 gramme. In the third period the excretion was 7.3 grammes, the intake 7.4 grammes, the gain 0.1 gramme; 7.4 grammes of nitrogen correspond to 46 grammes of digestible albumen, a quantity very much smaller than Rubner's 81 grammes.

In a research of this character a three days' test is utterly worthless, because it takes the organism from six to twelve days to come into equilibrium with a new albumen ration.

The equilibrium was maintained, even when the albumen in the pure bread diet had been reduced to 46 grammes daily. I could not reduce it further, although I used rye very poor in albumen, coarsely ground and unbolted, so that about 40 per cent of its albumen was lost in the feces. The experiments, however, proved the practically important fact that a pure bread diet sufficient for general nutrition supplies enough albumen to cover the daily outgo.

Theoretically, it would be interesting to investigate the possibility of maintaining equilibrium with a still smaller quantity of albumen. In some old experiments of this sort the subjects were fed on bread made of starch, but the bread was so poor that no subject could eat it for a long period. In other experiments sugar, starch and fat, prepared in various ways, were used, but this diet produced nausea, heartburn, gastric pains, and diarrhœa. Nobody appears to have thought of the simple expedient of adding fruit to a bread diet. Strawberries, prunes, and other fruits contain little albumen and almost no digestible albumen, and they can be eaten in large quantities. A very palatable dish can be made of prunes, starch, and sugar. I found that a diet of this sort never caused digestive troubles. A typical daily ration comprised about 17½ ounces (500 grammes) of whole rye bread, 20 ounces of prunes, and 2½ ounces each of sugar, starch, and margarine. This ration contained 8.4 grammes of nitrogen, of which only 3.5 grammes were assimilated, the remainder being excreted by the bowels. But still the body gained nitrogen slightly, for only 3.4 grammes appeared in the urine; 3.5 grammes of nitrogen correspond to 22 grammes of albumen. This is little more than one quarter of Rubner's minimum (81 grammes) and is even less than his minimum allowance of meat albumen (25 grammes). Similar results were obtained in several experimental periods. The albumen of bread, therefore, is equal to the albumen of meat in nutritive value.

In earlier experiments, in which two subjects lived for a whole year entirely on potatoes and margarine, I found the minimum daily ration of albumen to be 20 to 25 grammes. This result also indicates that vegetable albumen is equal to animal albumen in nutritive value.

It may be asked whether my subjects remained healthy and vigorous on these diets. Rubner asserts that deprivation of albumen produces sluggishness, weakness, and unwillingness to work. If 81 grammes of albumen daily are required to maintain muscular strength, my subjects had good reason for weakness. In 162 days one of them received only 5,267 grammes of digestible albumen, instead of the 13,122 grammes corresponding to the daily minimum of 81 grammes. He should, therefore, have lost 8 kilogrammes of albumen, corresponding to 40 kilogrammes, or 88 pounds, of muscle.

This is more muscle than he possessed at the start and, as loss of any considerable proportion of the muscular weight is fatal, he should, theoretically, have died several times in the course of the experiment. This man, Frederik Madsen, has now lived for twelve years on a vegetable diet exceedingly poor in albumen. During the last eight years he has scarcely tasted milk or eggs, which many vegetarians consume in large quantities, and has very seldom eaten beans or peas. For a whole year he lived on margarine and potatoes, which usually contained only half of the normal percentage of albumen. In the following year he submitted to the six months' test described above. On Sundays and holidays, when he is not employed in my laboratory in Copenhagen, he works as a gardener, partly in order to earn money, partly for the sake of exercise. His capacity for work is so remarkable and so well known that he easily finds employment at high wages. During the spring of 1913, in the course of the six months' test, he worked in this way at a villa several miles from the city, going and returning on his bicycle, and working from one hour after sunrise until darkness compelled him to stop, without tasting food. (As a rule he never eats during working hours, except at my request, and he has never been induced to drink anything but water.) His employer testifies that work seemed play to him, and that he accomplished an astonishing amount of it, with never-failing cheerfulness and good humor.

In order to test the powers of the other and younger subject I allowed him, after the experiments were finished, to take part in a "Marathon" race of 262 miles, although, as he was entirely untrained, I did not expect him to complete the course within the time limit of 102 hours. He did so, however, in 99 hours.

A diet poor in albumen appears to increase endurance. I have never heard of a great meat eater winning a long-distance race.

It cannot be denied that meat "tastes good" to most persons, or that it stimulates metabolism, accelerates oxidation, and thus produces a temporary feeling of warmth and comfort. But the organs seem unable to endure this stimulation for long periods. The mortality from diseases of the liver, kidneys, and bowels is three or four times greater among well-to-do city dwellers than among peasants living chiefly on bread, potatoes, and fat. The Eskimos, who eat large quantities of meat, seldom attain the age of 60 years, and the mortality between the ages of 50 and 55 is four times greater in Greenland than in Denmark.

I am not a strict vegetarian, but I eat very little meat. My experiments have proved that health and strength can be maintained on a diet of whole grain bread, fat, potatoes and fruit, and experience has proved the same thing a thousand times. This fact possesses great interest in these times of threatened scarcity of food. Army rations are sometimes unsatisfactory because they are too complex. The Arabs live on bread and bananas and exhibit an endurance that the French and Italians find difficult to overcome. The daily ration of the Sikhs of India, reputed to be the best soldiers in the world, consists of about one pint of milk, 25 ounces of meal, 2 ounces of butter, 4 ounces of beans, and 5½ ounces of potatoes. They eat meat only two or three times a month.

* Abstract of Dr. Hindhede's article in *Die Umschau*. Translated for the Scientific American Supplement.

Measurements of Radium

In the recently issued circular of the Bureau of Standards on fees for various tests and investigations the following information in regard to radium is given.

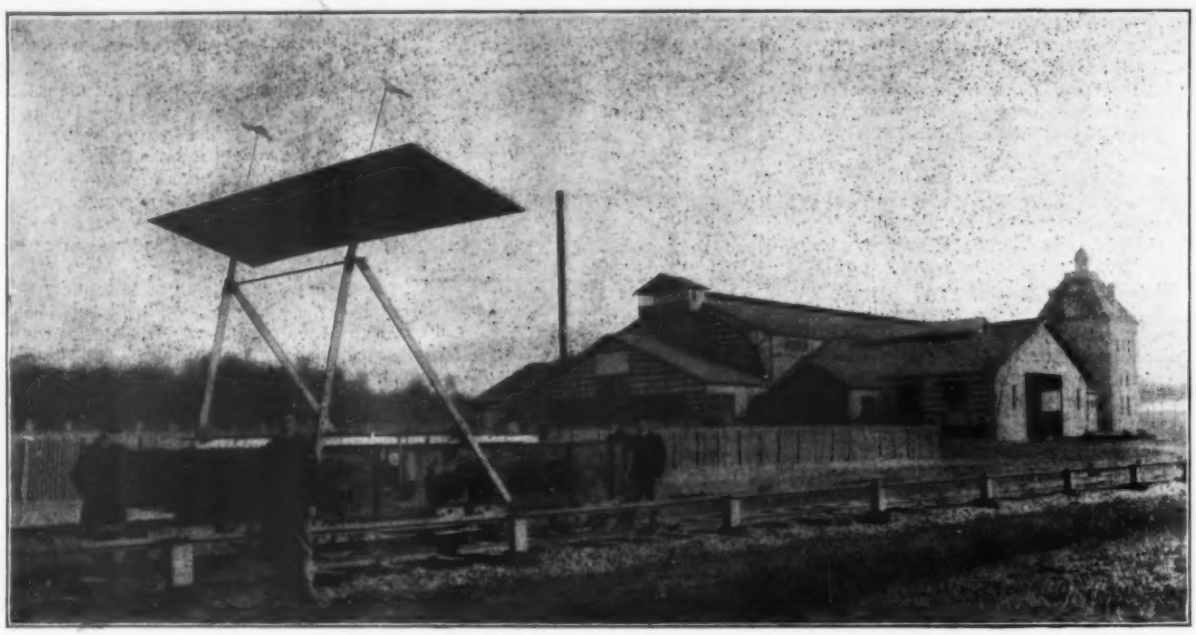
As recommended by the International Commission on Radium Standards, all determinations of the radium content of hermetically sealed specimens are based upon a comparison of the penetrating gamma radiation of the specimens with that of the standard.

This penetrating radiation proceeds not from radium itself, but from radium—C, one of the disintegration products of radium. Consequently, if the products of disintegration are entirely removed when the salt is sealed, there will at first be no penetrating radiation whatever; a measurement will give no indication of the presence of any radium in the specimen. Owing to the continual disintegration of the radium atom, the products of disintegration will at once begin to accumulate and at the end of four days radium—C and consequently its penetrating radiation will have reached about one half of its equilibrium value; and at the end of a month it will be within a half of a per cent of its equilibrium value. After equilibrium is reached the amount of radium—C in the specimen remains constant; or, rather, to be exact, it decreases at the same rate as radium disintegrates, namely, about one half in 2,000 years.

On the other hand, if only radium emanation (a gaseous disintegration product of radium) is sealed in a tube, the amount of radium—C which is in equilibrium with the amount of emanation will be formed almost immediately, and an observation will show the presence of an intensity of the penetrating radiation which is equal to that emitted by a tube which contains a certain amount of radium and which has been sealed for over a month. That is, a tube containing *no* radium may give a penetrating radiation equal to that given by a tube containing radium.

If the tube containing only radium emanation and its disintegration products is observed again, four days later, its penetrating radiation will be found to be only one half of what it was before; after a month the radiation will have practically disappeared.

Thus, it is evident that no conclusion as to the amount of radium in a tube can be drawn from measurements made upon a single day. The actual amount of radium may be either greater or less than that indicated by the observed intensity of the penetrating radiation.



Aerotechnic Institute of Saint-Cyr, view of first platform equipped for a trial.

European Aeronautical Laboratories—I*

Their Organization, Equipment and Methods of Investigation

By A. F. Zahm, Ph.D.

DURING August and September, 1913, in company with Jerome C. Hunsaker, Assistant Naval Constructor, U. S. N., I visited the principal aeronautical laboratories near London, Paris, and Göttingen, to study, in the interest of the Smithsonian Institution, "the latest developments in instruments, methods, and resources used and contemplated for the prosecution of scientific aeronautical investigations."

These establishments resemble each other in some important features, but differ in others. All are devoted to both academic and engineering investigations. All are directed by highly trained scientific and technical men. The directors are not merely executives; they are the technical heads—scientists or engineers specifically qualified by superior training in aeronautical engineering and its immediately cognate branches—who initiate the researches, and assist their technical staffs in devising apparatus, interpreting results, and making systematic reports.

The establishments differ in their organization, resources, and equipments, and, to a considerable extent, in the scope and character of their investigations. Of the five institutions mentioned, the one in England and the one at Göttingen are now supported largely by governmental appropriations; and the other three are maintained by private capital, allotted as required, or accruing from fees or endowment funds. Again, the laboratories near London, at St. Cyr, and at Adlershot are practically unlimited in the scope of their researches, while Eiffel's and the Göttingen laboratory have confined their activities substantially to wind-tunnel experiments.

The aeronautical researches of the British government are in charge of the British Advisory Committee for Aeronautics, a self-governing civilian organization which was appointed by the Prime Minister of England to work out theoretical and experimental problems in aeronautics for the army and navy, and comprises twelve to fourteen expert men, under the presidency of Lord Rayleigh. This committee initiates and directs investigations and tests at the Royal Air Craft Factory, at the National Physical Laboratory, at the Meteorological Office, at Vickers Sons & Maxim's, etc. It expends, in performing its regular functions, a sum exceeding the income of any private aeronautical laboratory, and received directly from the government treasury.

The committee is primarily occupied with work for the government, but also performs researches and tests for private individuals, for suitable fees, but without guaranteeing secrecy as to the results. The work of the committee is manifold and comprehensive. Whirling-table measurements, wind-tunnel measurements, testing of engines, propellers, woods, metals, fabrics, varnishes, hydromechanic studies, meteorological observations, mathematical investigations in fluid dynamics, the theory of gyroscopes, aeroplane and dirigible design—whatever studies will promote the art of air craft construction and navigation may be prosecuted by this committee. A detailed programme and the results of actual investigations have been published in the annual report of this committee.

M. Eiffel has paid from his personal fortune all the expenses of his plant and elaborate researches, though it is understood that he may sometimes charge nominal fees for investigations made for private individuals who wish exclusive rights to the data and results obtained. The general director of the laboratory is Eiffel himself—who initiates the researches and publishes the results. He has in immediate charge two able engineers, MM. Rith and Lapresle, aided by three trained observers who are skilled draughtsmen. Two mechanics and one janitor complete the personnel. The work of the laboratory is all indoors, and is confined to researches in aerodynamics alone, or more specifically to wind-tunnel measurements and reports thereon.

The institute at St. Cyr was founded by Deutsch de la Meurth, who gave $100,000 for the original plant and has provided $3,000 per year, during his life, for maintenance. It was presented by him to the University of Paris, and is now under the general direction of the professor of physics, M. Maurain, aided by a technical staff and a large advisory council of eminent engineers, scientists and officers of the university, officers of the French government and members of various clubs and aeronautical organizations. The staff comprises the director in charge and his assistant, together with such students, two or three at a time, as may come as temporary volunteers from the University of Paris.

The institute conducts large-scale experiments in the open fields as well as indoor researches, makes investigations for general publication or for private interests, on payment of suitable fees, and permits private persons to conduct researches in the laboratory. The scope of the work is practically unlimited, as is the case in the English aeronautical laboratories. A special feature of the institute is its three-quarter mile long track with electric cars for tests on large screws, large models and full-sized aeroplanes.

The Göttingen aerodynamical laboratory was begun as a private enterprise, but is now to be enlarged and maintained in part by financial aid of the Kaiser Foundation. The original building, with its wind-tunnel, was erected in 1908 after the plans of its director, Prof. Prandtl, of the University of Göttingen, at a cost of 20,000 marks.

ENGLISH AERONAUTICAL LABORATORIES.

Aeronautical laboratories used by the British government.—Of the various aerotechnical plants supervised or used by the British Advisory Committee for Aeronautics, we visited the one at the National Physical Laboratory, at Teddington, and the one at the Royal Air Craft Factory, at Farnborough; but not the meteorological stations, nor the plants of private concerns working for the committee, such as Vickers Sons & Maxim.

The National Physical Laboratory, which corresponds to the U. S. Bureau of Standards, is under the directorship of Dr. R. T. Glazebrook, F.R.S., chairman of the Advisory Committee for Aeronautics; its engineering department is directed by Dr. T. E. Stanton; and the subdivision of this assigned to aeronautic investigation is in general charge of Mr. L. Bairstow.

The part of the National Physical Laboratory devoted exclusively to aeronautics comprises the whirling-table house, the large wind-tunnel house and the small wind-tunnel house with its liberal space for minor apparatus. The parts available for aeronautics, but not exclusively devoted thereto, are the general grounds, the large marine model tank, the ample shops for wood and metal working, the store rooms, the offices and library, the heating and lighting system, etc.

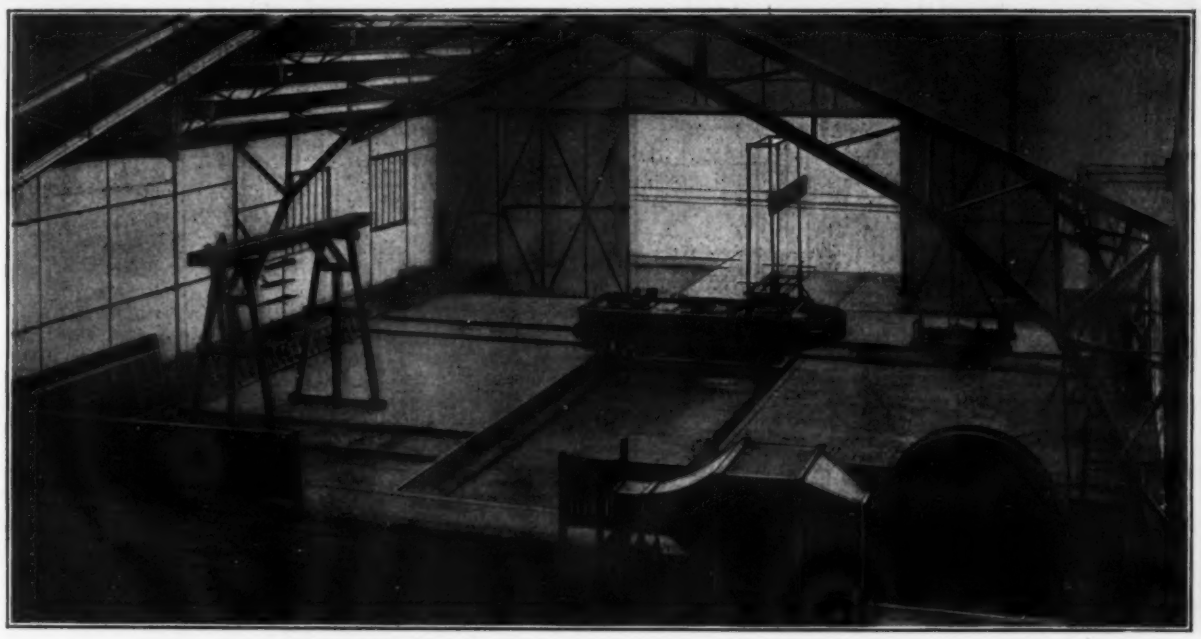
The whirling-table house, a separate building, is a corrugated iron shed some 80 feet square, having an earth floor, and at its center a motor driven vertical shaft which supports a trussed horizontal arm and causes it to whirl at any desired speed, its outer extremity describing a circle about 60 feet in diameter, and carrying in steady flight any model that has to be tested. The most important use of this whirling table hitherto made seems to have been to prove what was demonstrated and published in America by myself about one decade previously, viz., that a suitably designed pressure-tube anemometer is competent to measure the velocity of a uniform air current accurately to one per cent, or less,[1] and needs no calibration when its readings are interpreted in accordance with Bernouili's theorem. The whirling arm has also been used to test model screw propellers, but is not necessary for this work, and is much less convenient for the purpose than the wind-tunnel, as used by Eiffel, for example.

The large wind-tunnel house, a wing of the engineering laboratory, is a concrete structure 100 feet long, 40 wide and 30 high, having a wooden horizontal wind-tunnel placed equidistant from the side walls, and midway between floor and ceiling, and supported between concrete columns reaching from floor to ceiling.

The large tunnel is some 80 feet long and 7 feet square in cross-section from its mouth to its middle; it expands considerably through the rest of its length. Its larger extremity abuts against the end wall of the room, while its mouth stops well short of the opposite wall. At mid-tunnel, just aft the enlargement, is placed a low-pitch wooden screw actuated by a 30 horse-power electric motor, and designed to give a current of 60 feet a second in the fore part of the tunnel. The screw sucks the air of the closed room through the mouth of the tunnel, which is somewhat flaring, thence through a metal honeycomb, into the experimental part of the tunnel, where the models are placed for study. Thence the air flows into the expanded half of the tunnel, passing first through the screw, then laterally outward through innumerable holes in the tunnel wall, thence in uniform circulation through the unobstructed room till it curves again easily into the mouth

* Smithsonian Miscellaneous Collections, vol. 62, No. 3.

[1] The calibration made at the British laboratory is reported to be reliable to one-tenth of one per cent.



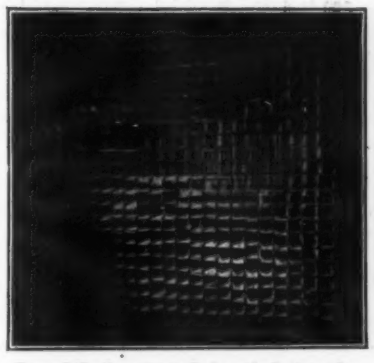
Aerotechnic Institute of Saint-Cyr. Garage of electric platforms.

at the opposite end. The air stream so produced is, where it emerges from the honeycomb, uniform in velocity at all parts of a section, at least to a fraction of one per cent, if due care be taken. The expanded and perforated part of the tunnel is said to be the final outcome of long months of trial and study by the technical staff, and has enabled them to produce the steadiest aerodynamic current in the world; thus removing one of the greatest difficulties in the accurate determination of the flow and pressure of air about wind models. The current velocity is reported to be uniform to one half per cent both in time and space.

The complete structure of the tunnel need not be delineated here, as it may be had better from the general plans and detailed working drawings which the director of the laboratory has kindly offered to furnish the Smithsonian Institution. It may be explained, however, that the "honeycomb," just within the flaring mouth of the tunnel, consists of crossed metal sheets forming, post-office-box-like, a tubular partition of many cells through which the air entering the tunnel is straightened and deprived of eddies. It may also be observed that a glass door is placed on the side of the tunnel, through which one may take observations, or enter to adjust the models to be tested.

The cost of the 7-foot wind-tunnel is given as about $2,000, and of its wind balance about $2,000. This, with an expenditure of $12,500 for the building, makes a total of $16,500 for the plant.

The velocity of the air flow in the unchecked current, near the model held inside the tunnel, is computed from the observed pressure difference between the inside and outside of the tunnel wall. The accuracy of this method was experimentally proved by me in 1902 at the request of the Navy Department, and, together with a mathematical proof, was set forth in the *Physical Review* the following year. It was there shown that the speed of air rushing steadily through a horizontal cylindrical tube from the quiet atmosphere of the room into a chamber at low pressure is, for ordinary transportation speeds, given truly to a fraction of one per cent by the formula $V=\sqrt{\frac{2g}{\rho}(p_o-p)}$, p_o-p being the pressure difference between the room and chamber, V the speed[1] of inrush, and ρ the nearly constant density. The method has since been adopted at Eiffel's laboratory and at the National Physical Laboratory.[2] This for the speed of flow; the direction may be shown by fine silk threads moored in the current, or by floating particles, fine streams of smoke, etc. In passing it may be mentioned that the direction of flow in the unchecked current is parallel to the tunnel walls truly to a fraction of one degree.



Prandtl's honeycomb in wind tunnel.

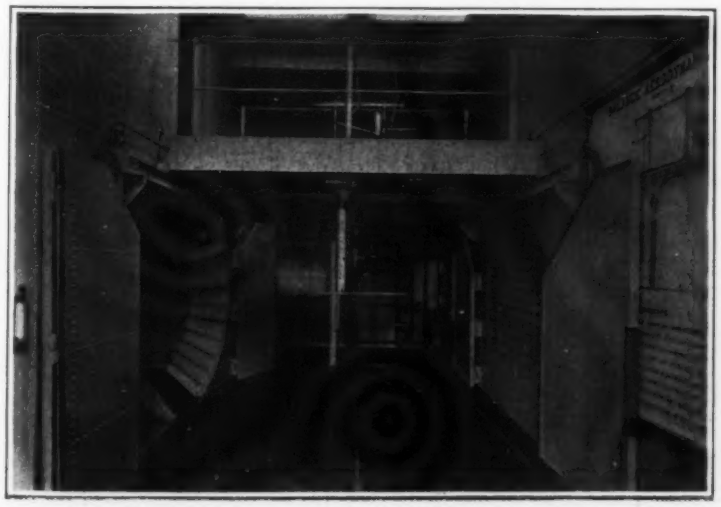
The pressure difference in question is found by connecting the interior of the tunnel wall by means of external nipple and hose to one branch of a U tube manometer whose other branch opens into the quiet air of the room; then observing the difference of level of the liquid in the two arms. Manometers are made in many forms, according to the accuracy desired. The English one, known as the "Chattock tilting gauge," made public in 1903, measures barometric pressure differences truly to one five hundred thousandth of an atmosphere. My gauge, made in 1902 on a different principle, was graduated to millionths of an atmosphere and for the most accurate measurements of static pressure differences was always read to tenths of a graduation. At Eiffel's laboratory, and at various other places, a less accurate, but somewhat similar, manometer gauge is used. It consists merely of an inclined alcohol tube suitably mounted beside a graduated scale. The latter instrument, a long known type of gauge, I would recommend for its convenience; but where great precision is required the English gauge or mine would perhaps serve better.

Such gauges are equally useful for measuring the difference between some standard pressure and the actual pressure at various points on the surface of a model, or elsewhere. Thus one arm of the U tube may be connected with the internal surface of the tunnel while the other arm is connected successively to various points on the surface of a model. The difference between the standard wall pressure and that at each point of the model surface may then be plotted, giving a diagram of surface pressure distribution all over the model.

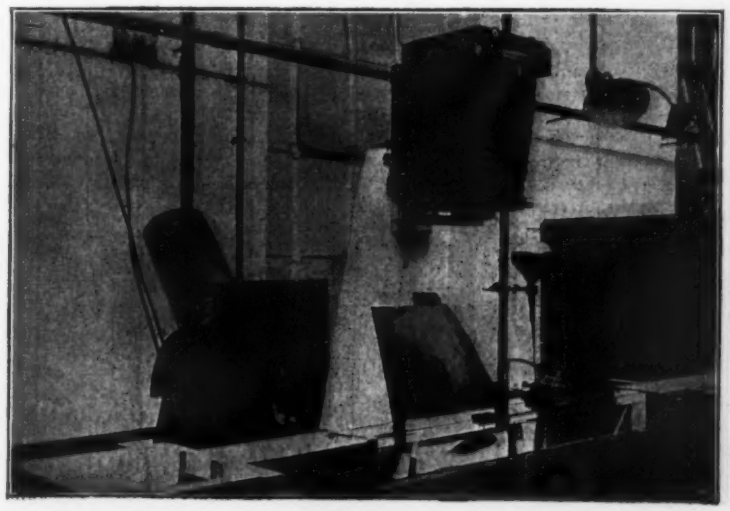
The wind balance.—Besides the pressure distribution and resultant pressure on models, it is desirable to determine also the total wind force, which is composed of both the pressure and the friction of the air. To this end the English experimentalists use a bell-crank balance which is a modification of the type devised and used in my laboratory, and now employed also by Eiffel for the accurate measurement of small wind forces. The English balance consists of two horizontal weighing arms, one parallel to the tunnel, the other perpendicular, attached to a round vertical tube, or arm, supported at its center on a conical pivot just beneath the tunnel floor. The vertical arm of the bell-crank balance has its upper

[1] More strictly speaking, V is the *increase* of velocity of the air as it flows from the room into the tunnel: but as the air starts from near rest, the increase of velocity is practically the whole velocity of inflow. A considerable error may ensue if V be taken as the true speed of inflow for the case of a tunnel of goodly section as compared with that of the room. Thus for the new English tunnel the cross-section is 7 x 7 feet in a room whose section is 30 x 40 feet. Hence the average speed of flow through the room is 4 per cent of the speed through the tunnel. Hence something like 4 per cent must be added to the speed computed from the true static pressure difference in question.

[2] At the National Physical Laboratory, the velocity along the axis of the tunnel as computed from the pressure difference inside and outside the tunnel wall is corrected by use of a small calibration constant obtained by placing a Pitot tube in the center of this tunnel before the place where the models are tested.



Experiment room, Eiffel Aerodynamical Laboratory.



Water channel at National Physical Laboratory, England.

half extending through the tunnel floor up to the center of the current and is duly shielded by a stream-line incasing sheath, while its lower half extends downward from the pivot and dips into a pail of oil intended to damp the oscillations. The upper half supports at its extremity the wind model and near the pivot has a graduated joint, so that it can be rotated about its own axis, and thus orient the model as desired. Sliding weights on the two weighing arms are made to measure the components of wind force parallel to the flow and perpendicular thereto. If the wind force tends to rotate the balance about the vertical axis, this tendency, or wind moment on the model, is determined by observing what horizontal restraining force must be applied to one of the horizontal arms to prevent such turning. Thus the balance may be used to measure lift, drift and center of pressure. There are numerous ingenious and important details, such as those for studying stability coefficients, which can best be obtained from the British Aeronautical Committee's technical report for 1913, or from the working drawings which the laboratory has furnished the Smithsonian Institution. Though this aerodynamic balance is accurate and moderately convenient, I am of the opinion that several new types can be devised which shall be equally precise and probably more expeditious, requiring less adjustment at each change of model. Such new types I have had in contemplation since first devising the bell-crank aerodynamic balance, in 1902.

The small wind-tunnel house, a wing of the engineering building, is of structural iron and covers rather more space than the room just described. Its chief apparatus is a 4-foot wind channel for testing small models. Other apparatus in this room are an engine testing plant, now dismantled; a horizontal water channel, described in the Advisory Committee's report for 1912-13; and a small vertical tube down which tobacco smoke, formed at its top, can be sucked by an up-draught in a parallel pipe beside it having a burning gas jet in the bottom to maintain a heated column, the purpose of the descending air mingled with the smoke being to delineate the flow about models immersed therein and visible through the glass sides of the tube.

The small wind-tunnel is the working prototype of the 7-foot tunnel already described. Made of one inch lumber, it measures some 40 feet in length and is supported more than 6 feet above the floor by heavy angle iron trestle work which also forms the framing for the wooden tunnel wall. The first half of the tunnel measures 4 feet square; the second half, joined to it by an expanding metal cone, measures 6 feet square, is thickly perforated with inch square holes in its side, and has its farther end abutting against the brick wall of the room. In the expanding cone at mid-tunnel is a low-pitch four-blade wooden screw driven by a steel shaft proceeding from a 10-horse-power electric motor on a wall bracket at the large closed end of the tunnel, and capable of maintaining an air current of 40 feet per second in the 4-foot tunnel. The character of the air flow and the instruments used are practically the same for the small as for the large tunnel. Some $20,000 was expended in developing and constructing this small tunnel and its appurtenances.

The small water channel, some 4 inches square in cross-section, has been used to exhibit the stream-line flow about models of ships' hulls, aeroplane posts, inclined wing forms, etc. By photographing the stream, duly dotted with tiny particles of foreign matter, clear pictures of the stream-lines and eddies have been obtained. These serve to show what forms are likely to encounter least resistance in moving through a fluid. But it can hardly be supposed that the phenomena of flow about a model slightly submerged in a shallow stream of water are identical with those for deep submergence in the atmosphere, unless for very slow speeds.

Wind-towers.—On the ground to the west of the National Physical Laboratory buildings, two wind towers, each 60 feet high and provided with rotating platforms 20 feet long, are used to determine the flow and pressure of free air about large-scale models. The first results of such determinations were published by Dr. Stanton in the proceedings of the Institution of Civil Engineers for 1907, and later studies may be found in the reports of the Advisory Committee. The Smithsonian Institution can doubtless obtain a like service from the three tall radio towers in its neighborhood.

The Royal Air Craft Factory, under the direction of Mr. Mervin O'Gorman, member of the Advisory Committee, is adjacent to the headquarters and flying grounds of the Military Wing,[4] at South Farnborough. Its work is co-ordinated with the aeronautical researches of the National Physical Laboratory, and is professedly concerned with the scientific improvement of air craft construction, though in reality directed at times to the manufacture, on a large scale, of aeroplanes, propellers and parts of dirigibles. The factory construction and research are in charge of a civilian staff which co-operates with the Advisory Committee for Aeronautics in performing aerotechnical work for the naval and military branches of the aerial service. The close co-ordination of the Air Craft Factory with the Flying Corps and with the Advisory Committee is an obvious advantage to the progress of aerotechnics, which might be still further enhanced if all the experimental plants were in one locality as proposed for the United States.

Apparently no very sharp line separates the aerotechnical work of the Royal Air Craft Factory from that of the National Physical Laboratory. Both have a whirling table; both have an engine testing plant; both have studied the materials of construction; both design instruments. But this overlapping is not excessive. Broadly speaking, the laboratory investigates models; the factory full-scale air craft, parts and appurtenances.

The factory investigates, developes, manufactures, and tests air craft. It is a mammoth plant, covering many acres and comprising half a dozen large buildings. It is said to expend half a million dollars per year and to employ 700 men, 400 of them working on aeroplanes. It has facilities for producing daily one complete aeroplane, excepting the engine, which at present is bought elsewhere. Its air craft are systematically tested on the great flying field nearby, bearing instruments which reveal their complete working in practical maneuvers. One instrument alone, called the "ripograph," records simultaneously the angles of pitch, roll and yaw, the speed through air, the altitude, the three control movements and the time. The stress in the wires, the propeller thrust and the pressure distribution on the wings and other surfaces may likewise be recorded.[5] The establishment does in fact the work planned in the United States for both the field laboratory and the experimental air craft factory. But the Royal Air Craft Factory lacks some of the facilities planned for our plant, such as an expanse of water for testing naval aeroplanes, and the immediate accessibility of allied laboratories, workshops and other resources.

The result of the full-scale experiments has been to disclose the defects of the leading types of aeroplanes, and to indicate means of betterment. Substantial improvement has been made in the efficiency, stability, factor of safety and range of speed of the aeroplanes specially studied at the factory. The final outcome has been to produce a stable, efficient and safe biplane having a range of speed of 40 to 80 miles an hour. It is expected shortly that a standard control will be adopted after the best types have been given a comparative test. The type at present most in favor is the Deperdussin control, which rotates a wheel for warping, shoves it for elevating, and uses a foot lever for steering. Such practical full-scale work cannot be too strongly recommended for the Smithsonian Institution, especially if the army and navy will, as already intimated, furnish for such tests their typical air craft and their experienced pilots.

Other English aeronautical laboratories worth mentioning are those of the Northampton Polytechnic Institute, London, and of the East London College. For want of time I did not investigate these; but as their resources are very moderate and their reports have been irregular and meager, it is doubtful whether they contain any equipment materially worth adding to what has been hitherto described.

(*To be continued.*)

[4] It may be noted that the entire military aerial service of England is known as "The Royal Flying Corps," and is under general supervision of the Air Committee, itself a subcommittee of the Committee on Imperial Defense. The Flying Corps comprises at present four branches: The Central Flying School; the Naval Wing; the Military Wing; the Reserve. The Advisory Committee for Aeronautics is an independent body, appointed by the Prime Minister, and receiving its appropriations directly from the Lord of the Treasury.

[5] All these measuring and recording devices can be purchased from the Cambridge Scientific Instrument Company.

A Vibration Electrometer*

THE telephone and the vibration galvanometer have long been used to detect very small alternating currents and voltages. The telephone is very sensitive in the range of frequencies from 500 to 3,000 cycles, but has the disadvantage of responding to harmonics as well as to the fundamental. The vibration galvanometers are relatively insensitive to the harmonics, and are much more sensitive at the lower frequencies than is a telephone.

The sensitiveness of an instrument may be defined in terms of the *voltage* which must be applied to give unit deflection, or it may be defined in terms of the *current* which will give unit deflection. In order that either a telephone or a vibration galvanometer shall be very sensitive to an alternating *current*, it must be constructed of very fine wire. A limit is soon reached in this direction, due to the difficulties in making and handling very fine wire. A vibration electrometer will detect very much smaller alternating currents than either of the above instruments. Such an instrument has already been described by Greinacher,[1] although his description did not appear until after the instrument here described had been constructed. He adapted a Wulf electrometer, using a transformer in connection with the instrument.

The instrument here described is a modification of a quadrant electrometer. The need for it arose in connection with the measurements of very small capacities at low frequencies. By means of it, capacities of the value of a thousandth of a microfarad have been measured at 50 cycles with an accuracy about ten times greater than can be obtained by any vibration galvanometer in this laboratory. For smaller capacities, the advantage is still greater. However, it is useful only when the impedance of the bridge arms is very high, so that the current which flows through them is very small. Also it cannot be used at frequencies much above 100 cycles on account of the moment of inertia of the vane.

As the design is of such form as to make a mathematical treatment of its behavior rather simple, the equations governing its operation have been worked out in some detail.

The instrument consists of four metal plates set vertically in pairs, the diagonally opposite plates being connected. Between these a light aluminium vane is supported by means of a bifilar suspension. This vane is free to vibrate about a vertical axis. The plates correspond to the quadrants of a quadrant electrometer, while the vane corresponds to the needle. If an electrostatic charge is given to the vane, and an alternating electromotive force is applied to the plates, the vane will be forced to vibrate in the period of the applied electromotive force. If the natural period of the suspended system is identical with the period of the applied electromotive force, then the amplitude of vibration is largely increased. The natural period can be varied by changing the length of the bifilar suspension, by varying the distance between the suspensions, or by altering the tension on the suspensions. When in resonance, the amplitude will depend upon the damping, and as air damping is a large part of the total damping, the whole instrument is placed under a bell jar, from which the air can be exhausted.

This instrument is capable of detecting alternating currents of low frequency having a value as small as 10^{-13} ampere. The conclusions verified by experiment are as follows:

For any given adjustment of the instrument, the frequency at which maximum deflection is obtained depends upon the potential of the vane. As the potential of the vane is increased, the frequency at which maximum deflection is obtained is decreased.

When the voltage on the vane is increased, the deflection for a given voltage on the plates increases more rapidly than the first power of the voltage. The sensitivity cannot be increased indefinitely in this way, since the frequency will become zero before the sensitiveness becomes infinite.

The deflection is inversely proportional to the damping. It is shown experimentally that the damping due to a well-constructed suspension is exceedingly small.

As the damping is decreased, the range of frequencies over which the instrument can be used is greatly diminished. Hence, it is not important to decrease the damping beyond a reasonable point.

Upon closing the circuit or otherwise changing the current through the electrometer, some time is required before the amplitude of vibration becomes constant. This time will be increased as the damping is decreased.

The power required to give unit deflection when the applied electromotive force is in resonance with the instrument decreases in the same ratio as the damping.

* *Bulletin of Standards*, No. 229, by Harvey L. Curtis, Associate Physicist.

[1] *Phys. Zs.*, 13, pp. 338, 433; 1912.

Removing Tar from Gas

THE problem of removing all traces of tar from the gas has always presented certain difficulties, and from experiments recently carried out it would seem that an electrical method is likely to solve the problem. The principle introduced is similar to that used in the smelting industry for the precipitation of lead and other fumes. A specially constructed electrode, from which high-tension direct-current discharges emanate, is suspended in a cast iron inverted U-tube, constructed from standard 8-inch pipe covered on the outside with a jacketing of felt. The arms of the U-tube are each 9 feet long. The electrode consists of two cast iron disks 4-inch diameter and placed 5 feet 8 inches apart, connected by means of a light gas pipe. Fine discharge wires are stretched from disk to disk in the form of a squirrel cage. The high-tension discharge has the effect of causing all the tiny particles of tar to be precipitated.

The Telephotographic Apparatus of Georges Rignoux

Experiments in Sending Visible Forms by Electricity

By R. Arapu

THERE is so much interest in television that the accompanying report of progress in the experiments of Dr. Georges Rignoux will be of timely value. The photographs, while by no means perfect, are new, having thus far been published nowhere in Europe or America, and will serve to show precisely what is being done.—EDITOR.

FOR a very long time physicists have been trying to solve the problem of seeing at a distance and as science has already made such marvelous conquests—the telegraph, the wireless sending signals, and the telephone conveying the sound of the voice to a distance, and now also without the intervening wire, that television, seeing at a distance, seems no longer merely an impossible dream.

The present story has to do with some experiments which Prof. Ruhmer in Berlin, Edouard Belin at Paris, and Georges Rignoux at la Rochelle, have been conducting. These have been in progress for some years, and have just reached a stage that is filled with interest, for it has been possible to recognize simple form reproductions transmitted by electric impulses in a distant city.

Rignoux, who is a young physicist of la Rochelle, sometime since devised an apparatus to which he gives the name Telephote, but which required a large number of wires, as many as there were of luminous points constituting the original image. Latterly, he has been able to simplify the Telephote to a marked degree, and just as the telephone transmits over a wire gradations and quality of sounds so the Telephote will transmit the lights and shadows for the defining of an illuminated image.

The Telephote requires two wires between the sending and receiving stations, in addition to one for synchronizing the machines at the two places, and is based on the general principles illustrated in the accompanying diagram. A suitable concave mirror, parabolic by preference, concentrates upon the object whose image it is desired to transmit the beam of a Nernst lamp of 2,000 candle-power, and the image of the original thus illuminated is projected by means of a lens upon a mosaic of 64 cells of selenium. It is not necessary here to do more than note that the electrical resistance of selenium varies according to the amount of light which it receives, a property which has caused it to be made the foundation of many experiments of the kind.

Such a mosaic is capable of transmitting various figures and combinations of signs, the current passing to the selenium being of 110 volts. Each cell that is illuminated attracts the armature of its own electromagnet, but if there is no light there is no movement of this armature. The result of the projection of an image upon the mosaic will be that certain cells close armatures that permit currents to flow, and these currents are sent to a "collector" which rotates at 450 turns a minute, and the collected currents are delivered to the line by this device.

At the receiving end the impulses are conducted to a solenoid or coil, the axis of which is hollow. The beam of an arc light is directed by condensing and projecting lenses upon a nicol prism, and then passes through the solenoid. When it emerges it comes upon a second nicol prism that is reversed to the first, and the normal result is that the second prism entirely stops the light already polarized by the first. The effect of the current through the solenoid is, however, to change the plane of polarization of the beam of light, and make it possible to pass the second nicol. It is then caught by a lens, passed through a diaphragm which holds back all but the central rays, and these fall on mirrors fixed to the periphery of a wheel. A convenient screen receives the reflections from the turning mirrors, and on this screen will be seen the transmitted image of the distant original.

Dr. Rignoux has succeeded in sending in this way, by means of the Telephote in his laboratory, the images of the letters of the alphabet, H, T, L, and U among them, and the photographs shown are taken from these images. By removing the screen the eye can catch the images on the mirrors but not as sharply.

Thus far these investigators have not attempted to send any half-lights, but are now experimenting with this end in view. To obtain an image of a person it will be necessary to have a selenium mosaic of from 3,000 to 4,000 cells. It is believed also that in time the receiving screen will not be necessary, and when this is dispensed with the image formed will be much stronger and clearer. The present intensity of this image is weak. Dr. Rignoux and his associates do not claim that the problem of television is solved, but the report that they make is an interesting statement showing that important advances have really been made.

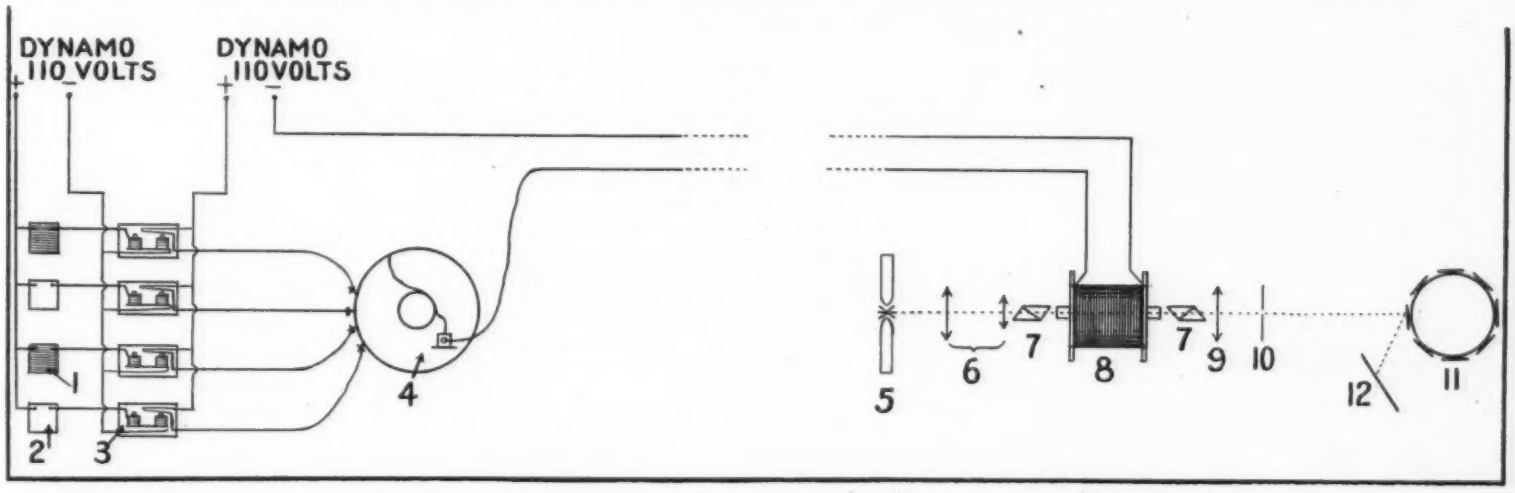


Diagram of the Rignoux telephotographic apparatus.

1. Selenium cell not illuminated. 2. Selenium cell illuminated. 3. Electromagnets (relays). 4. Relay collector. 5. Arc light. 6. Projecting lenses and condenser. 7. Nicol prisms. 8. Solenoid. 9. Projecting lens. 10. Diaphragm. 11. Revolving mirrors. 12. Screen receiving image.

The Coolidge Tube in Metallurgical Research*

By Dr. Wheeler P. Davey

DR. WEINTRAUB in the February, 1913, number of the *Journal of Industrial and Engineering Chemistry* describing boron and its compounds says:

"Boron suboxide, a by-product obtained in the manufacture of boron, can be used for obtaining high conductivity cast copper. Copper cast without additions is full of pores and blowholes, and therefore mechanically unfit and of very low electric conductivity; the removal of the gases from copper by the known deoxidizers is liable to give an alloy containing a small amount of deoxidizer, an amount sufficient, however, to lower the conductivity of the copper very considerably. Boron suboxide, however, has the property of deoxidizing copper without combining with it, as boron suboxide has no affinity for copper.

In the refining of copper for electrical purposes, the electrically deposited metal is melted in a reverberatory furnace. A world of delicate chemical control is connected with this furnace refining.

If the metal were merely melted and then poured the casting would be full of blow-holes and would be of low electrical conductivity. The molten copper is allowed to oxidize in the furnace and the oxidation is augmented by air blown into the metal. When the melt contains 5 or 6 per cent of oxide, the major part of the other impurities have been burned away and the work of reduction is started. As ordinarily done, this consists in the so-called "poling." Green sticks are submerged in the molten copper and the gases and carbon reduce the oxide, and such harmful products as sulphur dioxide are driven out of the metal. The proper time for pouring is not that representing complete reduction of all oxide, as it has been determined by experience that over-poling also gives a porous inferior ingot.

It was once believed that the copper absorbed carbon which in over-poled copper caused the rising in the mold and the porous condition when cast. Hampe corrected this idea and attributed the porous state of over-poled copper to the effect of absorbed hydrogen and carbon monoxide.

The use of the boron flux of Weintraub has done away entirely with the difficulty of obtaining sound castings of high electrical conductivity. It seemed interesting to illustrate the effect on the porosity by an investigation using X-rays. For this purpose some high grade copper was melted in the usual way and poured into a sand mold to give a block 10 by 10 by ¾ inches. Another portion was treated with one per cent of the boron flux at the time of pouring and was cast in a similar mold. These two castings were then placed side by side on an 8 by 10-inch Seed X-ray plate, 22 inches from the focal spot of a Coolidge X-ray tube and exposed for two minutes. The current through the tube was 2.8 milli-amperes and the potential difference across the tube corresponded to a 10-inch parallel spark gap between points. The resulting radiograph showed the copper cast in the ordinary way to be full of pores. The cast with the boron flux was so perfect that no holes were visible. The two castings were then taken to the machine shop and a portion of the surface of each was machined as smooth as possible, and, as was to have been expected from the radiographs, the holes were clearly visible in the common copper, while in the "boronized" copper the holes were either entirely absent or were microscopic.

The advantage of the radiograph in experimental work is obvious. Without the use of X-rays it is necessary to machine off layer after layer of the sample in order to expose to view any hidden defects. Even when this is done it remains for the experimenter to build up a mental picture of the defects in his casting on the basis of what he has seen on each of the exposed layers. From the radiograph it is possible to see *all of these defects at once* without destroying the casting. If it seems desirable, it is easily possible to make stereoscopic radiographs whereby the defects may be seen in their entirety and their depths easily estimated.

In view of the results shown above, the X-ray examination of metals as a means of metallurgical research seems to have certain attractive and desirable features not found in other methods and to open a wide field for further work.

*From the *General Electric Review*.

(Note: Two other articles describing practical and commercial uses of this new tube have appeared in the SCIENTIFIC AMERICAN SUPPLEMENT, as follows: "Applications of the Coolidge X-ray Tube" in No. 2019, for September 12th, 1914; and "An X-ray Inspection of a Steel Casting" in No. 2040, for February 6th, 1915. Copies of these can be supplied at 10 cents each).

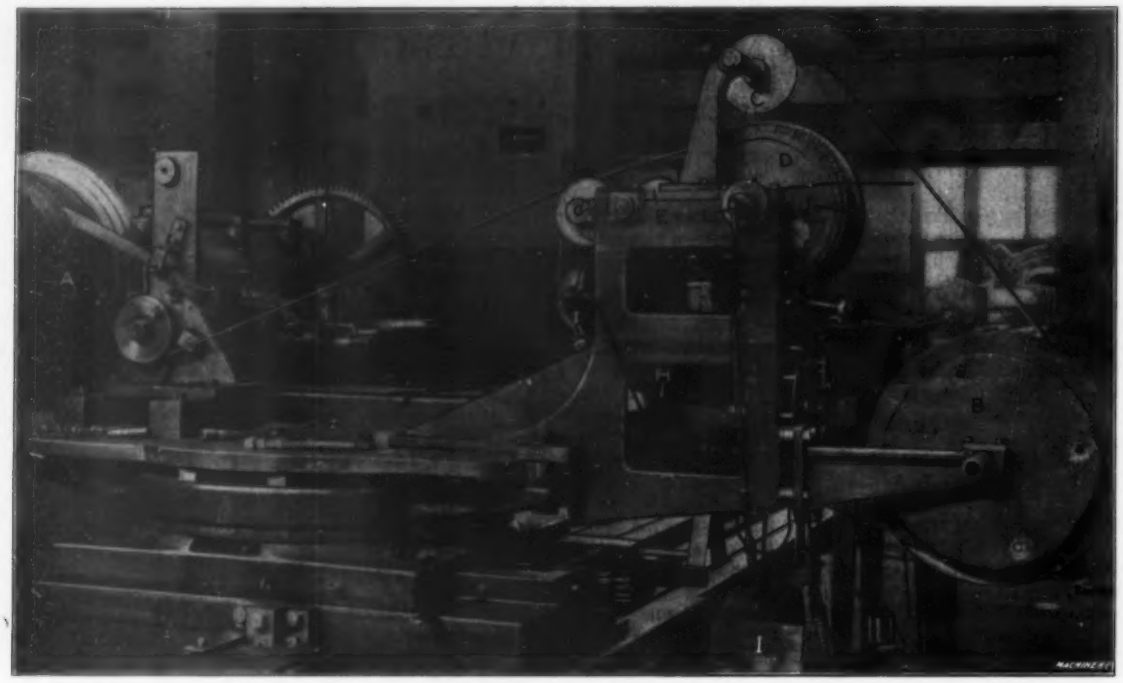


Fig. 1.—Important parts of machine used for winding wire on a 14-inch gun.

Wire-Winding Big Guns for Uncle Sam*

Methods by Which the Most Powerful Guns in the World Are Made

By Chester L. Lucas

THE strengthening of artillery by wire-winding is a subject that has received the attention of ordnance experts for years. There are many different opinions as to the merits of wire-wound guns, and they have been freely expressed by authorities in this country and abroad; therefore, it will not be attempted in this article to discuss wire-wound guns from the engineering standpoint, but rather to describe the details of the operation of applying the layers of wire to the gun as done in the United States Arsenal at Watervliet, N. Y.

The antiquity of the principle of reinforcing guns with wire is evidenced by an early cannon now in the museum at the Woolwich Arsenal in England, that is said to have been used by Gustavus Adolphus early in the seventeenth century. This cannon is about six feet in length, with a copper barrel, and is reinforced by being wound with hempen cord and then covered with leather. The practical application of this principle to modern warfare, however, commenced about 1850, with the efforts of Longridge in England and his contemporary Woodbridge in America. Since that time, the wire-wound gun has been used to a growing extent in Great Britain and Europe, but it is only during the past eight years that wire-wound guns have received official recognition in the United States. At the present time the wire-wound gun is used for coast defense only.

THE PRINCIPLE OF THE WIRE-WOUND GUN.

Before taking up the operation of wire-winding, a few words on the principle involved may not be amiss. Many years ago it became apparent to ordnance experts that a gun built up of successive tubes shrunk in place was far superior to a gun made from a solid billet. Under the gas pressure of firing, it was found that the metal nearest the bore of a solid gun was stretched beyond its elastic limit, while the outside metal was unaffected, receiving none of the strain. Therefore, no matter how thick the walls of the gun were made, the inner metal around the bore was the only part that received the gas pressure, and as soon as this metal became fatigued the gun was unfit for use. By building the guns of tubes, successively shrunk one over the other, it was found possible to close in the metal of the inner tube by shrink-pressure of the outer tubes so that when the gun was fired the metal of the inner tube had to be first expanded back to its natural condition and then stretched beyond its elastic limit before being fatigued. As the succeeding layers of these tubes were shrunk in position, this stretching of the inner tube was resisted by the pressure of each of the outside bands, and consequently the life of the gun was greatly lengthened; in addition, it was possible to build a much lighter gun of the same relative strength as the solid gun. From the above it will be seen that the winding of guns with wire that is under tension brings about the same condition as is obtained by shrinking on tubes successively, and it is claimed that the use of high tensile strength wire gives the gun strength attainable in no other way.

There are two principles employed in applying wire to guns, one of which consists in winding successive layers of wire at the same tension. The second system consists in winding the wire at a varying tension, decreasing with each successive layer. The first system is, of course, applied with the minimum amount of trouble, but it is claimed that the second principle has the advantage of distributing the firing strain in as nearly uniform a manner as possible.

Fig. 2 shows a sectional view of the Crozier type of wire-wound gun, reproduced from "Ordnance and Gunnery," by Capt. L. L. Bruff. This view is reproduced to illustrate the manner in which the layers of wire are distributed over the length of the gun. In each series of reinforcements, about ten layers of wire are applied. At the breech end of the gun, the reinforcement is heaviest. At the muzzle end the layers are fewer in number, but the wire is put on at a higher tension in order to give the necessary strength with the smallest amount of wire. Covering tubes are shrunk in place over the wire and each of these tubes is "stepped" so that it has a bearing on one of the adjacent tubes as well as on the layers of wire.

The wire used for this work in the United States is square in section, being one-eighth inch diameter with slightly rounded corners. The English and Continental practice employs for the most part wire of rectangular section. The material is cold-drawn steel, having a tensile strength of 180,000 pounds per square inch and an elastic limit of 140,000 pounds per square inch. Its quality is an all-important factor, and is maintained by rigid physical and metallurgical tests.

THE WIRE-WINDING APPARATUS.

Fig. 1 illustrates the operation of winding wire on a 14-inch gun. The work is done in a large gun lathe, and the gun itself is rotated, drawing the wire from the wire-reel as it is wound on the gun. Between the gun shown in Fig. 1 at *A* and the reel *B* is the tensioning mechanism. A similar tensioning mechanism is shown in Fig. 3, although the details of the latter are slightly different from those in Fig. 1. Both views, however, illustrate the principle. The wire, as it leaves the reel, passes over an idler *C* and thence between the two friction disks which are indicated at *D*. A guide wheel *E* is in contact with the edge of the friction disk, and insures that the wire enters properly.

When the wire passes between the halves of the friction disk, it just fits into a square recess, half of which is cut in each disk. A very powerful spiral spring presses the halves of the disk constantly on the sides of the wire, and it is one of the functions of guide wheel *E* to force the wire into the groove cut in the friction disk. The wire runs around the friction disks, being in contact for nearly three fourths of the circumference, and then passes over the fixed pulley *F*. From there it runs down over the floating pulley *G*, forming a loop, and back again over another groove in pulley *F*. The arrangement of pulleys *F* and *G* is much the same as in the familiar block and tackle. Pulley *G* that floats in the loop of wire has suspended from its center a lever *H* that is pivoted on the extreme left-hand end, and on the extreme right-hand end of the long arm is hung the heavy weight *I*, shown only in Fig. 1. The weight on this lever may be varied, of course, to change the tension on the loop of wire, but in the illustration Fig. 1 this weight is 240 pounds and the leverage is so compounded that there is a pull on the wire amounting to 625 pounds. From these figures it may be seen that the wire, as it is wound on the gun, is under a tension of 40,000 pounds.

On the shaft with the friction disk is a brake drum that, in connection with two brake-bands, one of which is shown at *J*, impedes the rotation of the shaft. The object of having two brake-bands is to regulate the "drag" that is being applied to the wire. The wider

* From *Machinery*, by Chester L. Lucas, associate editor.

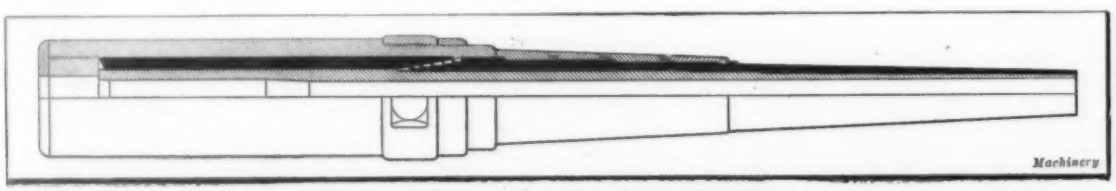


Fig. 2.—Section of Crozier type of wire-wound gun.

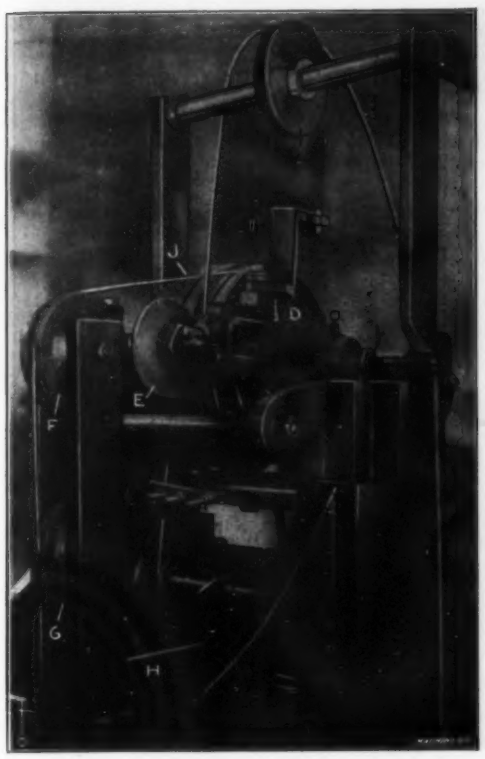


Fig. 3.—Mechanism for obtaining tension in winding wire.

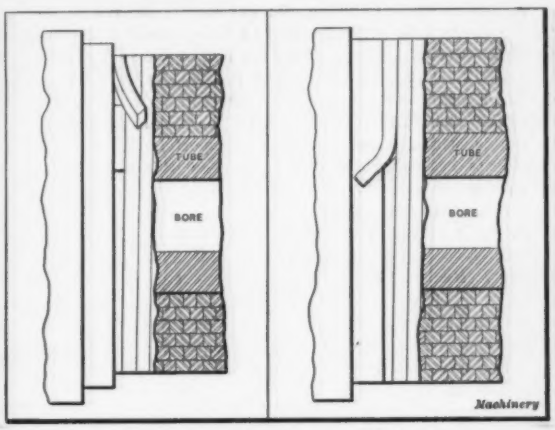


Fig. 5.—Diagram showing application of wire to gun.

Fig. 6.—Method of securing end of strand.

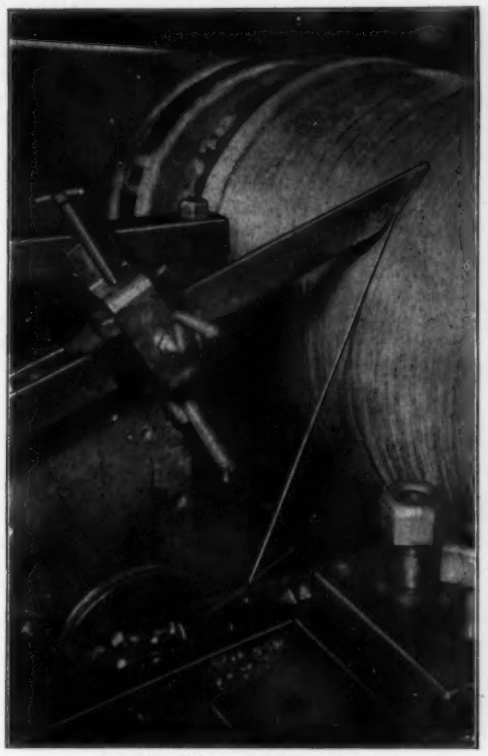


Fig. 4.—Wire wound onto gun.

of these bands is kept at a fixed tension, and the narrower is adjusted when increased or decreased drag on the wire is desired. The action of the brake and bands generates considerable heat, and to dissipate this, a stream of water passes through the center of the brake drum. The pipe for this purpose may be seen in the illustration, Fig. 3, entering the center of the axle at *L*. The drag of the friction upon the wire, on the one hand, and the pull of the wire as it is drawn onto the gun, on the other hand, support the wire while the tension is being secured. The compounded weight *I* that pulls upon the loop of wire around pulleys *F* and *G* gives this tension.

This lathe is geared so that the carriage holding the tensioning mechanism, wire and reel travels at the rate of one eighth inch to each revolution of the spindle. As the wire is exactly one eighth inch in diameter this, of course, is the proper lead. In order to make sure that the wire is wound closely, a spring finger bears against the strand of wire just before it is laid in place upon the gun. This insures that it is crowded over against the convolution previously applied. This may be seen on a large scale in Fig. 4. The wire is wound on the gun at the rate of from 120 to 240 feet per minute.

"FILLING IN" AT THE END OF THE LAYERS.

At the end of each layer of wire it is obvious that there will be a space that the wire cannot fill on account of the fact that the turns are helical. This space is one eighth inch wide at the beginning and tapers down to nothing at the end of the revolution, but even this slight space must be filled to complete the layer and form a good foundation for the next layer of wire. A strip of wire long enough to go around the gun is tapered for its entire length from one eighth inch at one end to nothing at the other end. This is also tapered for about an inch at the thick end to fit in under the strand of wire as it passes up to the next layer. These points are clearly shown in Fig. 5. This length of tapered wire is carefully driven into place and the new layer started on its course. At the beginning of this new layer it is also necessary to insert another filler wire to close up the space left. Thus two filler wires are required for each layer of wire wound. As these filler wires are several feet long and only one eighth inch square at the heavy end, it is rather difficult to hold them for planing the taper from end to end. The type of planing fixture used supports the wire on three sides, being clamped at six-inch intervals. Only the top is left open and but one wire is planed at a time.

When joining the end of one reel of wire to a new reel, the connection is made by electrically soldering with hard solder. The two ends of the wire are scarfed and clamped in the copper faced terminals of the electric heating fixture. Between the scarfed ends of the wire, a piece of sheet silver solder is placed and the joint well fluxed with a borax paste. The current is then turned on and ten seconds heats the ends, flows the solder, and completes the joining, and there is none of the "fuss" usually experienced when the blow-pipe is used.

On starting the strand of wire, the end is driven into a hole or recess in the gun body, and the end of the strand of wire on the last layer is also secured by being driven into a chiseled groove cut into the solid metal. The method of securing the end of the strand is illustrated in Fig. 6, and the groove is made small and deep enough so the wire can be driven down into it and the edges of the groove peened over onto the top of the wire, thus bolting it effectually.

After all the wire of the gun has been wound in place, a very light lathe cut is taken over the top layer, leaving the outside perfectly smooth so as to form a good surface upon which the next steel jacket may be shrunk. As the wire is cold-drawn to within limits of 0.001 inch there is very little unevenness, especially in view of the fact that it is under such high tension while being wound. The gun is now ready for the shrinkage on of the rings or covering tubes. The tubes are bored out to the external diameter of the wire, minus the allowance for shrinkage. Then, with the gun in a vertical position, breech down, and a stream of water within the bore to keep it cold, the shrink rings or tubes are heated and dropped into place. It may be well to draw attention to the fact that the shrinking on of these covering tubes is a very important operation and is done with great care.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

It would seem that the following account of the first American submarine would be of interest at this time. This narrative is taken from *The American Journal of Science and Arts*, volume II, published in 1820.

Glens Falls, N. Y. F. B. RICHARDS.

SUBMARINE NAVIGATION.

Article VIII. Description of a machine, invented and constructed by David Bushnell, a native of Saybrook, at the commencement of the American revolutionary war, for the purpose of submarine navigation, and for the destruction of ships of war; with an account of the first attempt with it, in August, 1776, by Ezra Lee, a sergeant in the American Army, to destroy some of the British ships then lying at New York. Communicated by Charles Griswold, Esq.

To Prof. Silliman:

LYME, CONN., February 21st, 1820.

Sir:—It is to be presumed that every person who has paid any attention to the mechanical inventions of this country, or has looked over the history of the revolutionary war, has heard of the machine invented by David Bushnell, for submarine navigation, and the destruction of hostile shipping. I have thought that a correct and full account of that novel and original invention would not be unacceptable to the public, and particularly to those devoted to the pursuit of science and arts.

If the idea of submarine warfare had ever occurred to anyone before the epoch of Bushnell's invention, yet it may be safely stated, that no ideas but his own ever came to any practical results. To him, I believe, the whole merit of this invention is unanimously agreed to belong.

But such an account as I have mentioned must derive an additional value and an increased interest from the fact that all the information contained in the following pages has been received from the only person in existence possessed of that information, and who was the very same that embarked in this novel and perilous navigation.

Mr. Ezra Lee, first a sergeant and afterward an ensign in the revolutionary army, a respectable, worthy, and elderly citizen of this town, is the person to whom I have alluded; to him was committed the first essay for destroying a hostile ship by submarine explosion, and upon his statements an implicit reliance may be placed.

Considering Bushnell's machine as the first of its kind, I think it will be pronounced to be remarkably complete throughout in its construction, and that such an invention furnishes evidence of those resources and creative powers which must rank him as a mechanical genius in the first order.

I shall first attend to a description of this machine, and afterward to a relation of the enterprise in it by Sergt. Lee, confining myself in each case strictly to the facts with which he has supplied me.

Yours, etc.,

CHARLES GRISWOLD.

Bushnell's machine was composed of several pieces of large oak timber, scooped out and fitted together, and its shape my informer compares to that of a round clam. It was bound around thoroughly with iron bands, the seams were corked, and the whole was smeared over with tar, so as to prevent the possibility of the admission of water to the inside.

It was of a capacity to contain one engineer, who might stand or sit, and enjoy sufficient elbow room for its proper management.

The top or head was made of a metallic composition, exactly suited to its body, so as to be water-tight; this opened upon hinges and formed the entrance to the machine. Six small pieces of thick glass were inserted in this head for the admission of light; in a clear day and clear sea-water, says my informer, he could see to read at the depth of three fathoms. To keep it upright and properly balanced, 700 pounds of lead were fastened to its bottom, 200 pounds of which were so contrived as to be discharged at any moment, to increase the buoyancy of the machine.

But to enable the navigator when under water, to rise or sink at pleasure, there were two forcing pumps, by which water could be pressed out at the bottom; and also a spring, by applying the foot to which a passage was formed for the admission of water. If the pumps should get deranged, then resort was had to letting off the lead ballast from the bottom.

The navigator steered by a rudder, the tiller of which passed through the back of the machine at a water joint, and in one side was fixed a small pocket compass, with two pieces of shining wood (sometimes called foxfire) crossed upon its north point and a single piece upon the last point. In the night, when no light entered through the head windows, this compass thus lighted

was all that served to guide the helmsman in his course.

The ingenious inventor also provided a method for determining the depth of water at which the machine might at any time be. This was achieved by means of a glass tube 12 inches in length and about 4 in diameter, which was also attached to the side of the machine; this tube inclosed a piece of cork that rose with the descent of the machine and fell with its ascent, and one inch rise of the cork denoted a depth of about one fathom. The principle upon which such a result was produced, and also the mechanical contrivance of this tube, entirely escaped the observation of Mr. Lee, amid the hurry and constant anxiety attendant upon such a perilous navigation.

But not the least ingenious part of this curious machine was that by which the horizontal motion was communicated to it. This object was effected by means of two oars or paddles, formed precisely like the arms of a wind-mill, which revolved perpendicularly upon an axletree that projected in front; this axletree passed into the machine at a water joint and was furnished with a crank, by which it was turned, the navigator being seated inside, with one hand labored at the crank, and with the other steered by the tiller.

The effect of paddles so constructed and turned in the manner stated, by propelling or rather drawing a body after them under water, will readily occur to anyone without explanation.

These paddles were but 12 inches long and about 4 wide. Two smaller paddles, of the same description, also projected near the head, provided with a crank inside, by which the ascent of the machine could be assisted.

By vigorous turning of the crank, says my informer, the machine could be propelled at the rate of about three miles an hour in still water. When beyond the reach of danger or observation of an enemy, the machine was suffered to float with its head just rising from the water's surface, and while in this situation air was constantly admitted through three small orifices in the head, which were closed when a descent was commenced.

The efficient part of this engine of devastation—its magazine—remains to be spoken of. This was separate and distinct from the machine. It was shaped like an egg and, like the machine itself, was composed of solid pieces of oak scooped out and in the same manner fitted together and secured by iron bands, etc. One hundred and thirty pounds of gunpowder, a clock and a gunlock provided with a good flint that would not miss fire, were the apparatus which it inclosed. This magazine was attached to the back of the machine, a little above the rudder, by means of a screw, one end of which passed quite into the magazine, and there operated as a stop upon the movements of the clock, while its other end entered the machine. This screw could be withdrawn from the magazine, by which the latter was immediately detached and the clock commenced going. The clock was set for running twenty or thirty minutes, at the end of which time the lock struck and fired the gunpowder, and in the meantime the adventurer effected his escape.

But the most difficult point of all to be gained was to fasten this magazine to the bottom of a ship. Here a difficulty arose which, and which alone, as will appear in the ensuing narrative, defeated the successful operations of this warlike apparatus.

Mr. Bushnell's contrivance was this: A very sharp iron screw was made to pass out from the top of the machine, communicating inside by a water joint; it was provided with a crank at its lower end, by which the engineer was to force it into the ship's bottom; this screw was next to be disengaged from the machine and left adhering to the ship's bottom. A line leading from the screw to the magazine kept the latter in its destined position for blowing up the vessel.

I shall now proceed to the account of the first attempt that was made to destroy a ship of war, all the facts of which, as already stated, I received from the bold adventurer himself.

It was in the month of August, 1776, when Admiral Howe lay with a formidable British fleet in New York bay, a little above the Narrows, and a numerous British force upon Staten Island, commanded by Gen. Howe, threatened annihilation to the troops under Washington, that Mr. Bushnell requested Gen. Parsons of the American Army to furnish him with two or three men to learn the navigation of his new machine, with a view of destroying some of the enemy's shipping.

Gen. Parsons immediately sent for Lee, then a sergeant, and two others, who had offered their services to go on board of a fire ship; and on Bushnell's request being made known to them, they enlisted themselves under him for this novel piece of service. The party went up into Long Island Sound with the machine and made various experiments with it in the different harbors along shore, and after having become pretty thoroughly acquainted with the mode of navigating it, they returned through the Sound; but during their absence the enemy had got possession of Long Island and Governors Island. They, therefore, had the machine conveyed by land across from New Rochelle to the Hudson River and afterward arrived with it at New York.

The British fleet now lay to the north of Staten Island, with a large number of transports, and were the objects against which this new mode of warfare was destined to act. The first serene night was fixed upon for the execution of this perilous enterprise, and Sergt. Lee was to be the engineer. After the lapse of a few days a favorable night arrived, and at 11 o'clock a party embarked in two or three whaleboats, with Bushnell's machine in tow. They rowed down as near the fleet as they dared, when Sergt. Lee entered the machine, was cast off, and the boats returned.

Lee now found the ebb tide rather too strong, and before he was aware, had drifted him down past the men-of-war; he, however, got the machine about, and by hard labor at the crank for the space of five glasses by the ship's bells, or two and a half hours, he arrived under the stern of one of the ships at about slack water. Day had now dawned, and by the light of the moon he could see the people on board and heard their conversation. This was the moment for diving; he accordingly closed up overhead, let in water, and descended under the ship's bottom.

He now applied the screw, and did all in his power to make it enter, but owing probably in part to the ship's copper and the want of adequate pressure to enable the screw to get a hold upon the bottom, his attempts all failed; at each essay the machine rebounded from the ship's bottom, not having sufficient power to resist the impulse thus given to it.*

He next paddled along to a different part of her bottom, but in this maneuver he made a deviation, and instantly arose to the water's surface on the east side of the ship, exposed to the increasing light of the morning, and an imminent hazard of being discovered. He immediately made another descent, with a view of making one more trial, but the fast approach of day, which would expose him to the enemy's boats and render his escape difficult, if not impossible, deterred him; and he concluded that the best generalship would be to commence an immediate retreat.

He now had before him a distance of more than four miles to traverse, but the time was favorable. At Governors Island great danger awaited him, for his compass having got out of order, he was under the necessity of looking out from the top of the machine very frequently to ascertain his course, and at best made a very irregular zigzag track.

The soldiers at Governors Island espied the machine and curiosity drew several hundreds upon the parapet to watch its motion. At last a party came down to the beach, shoved off a barge, and rowed toward it. At that moment Sergt. Lee thought he saw his certain destruction and, as a last act of defense, let go the magazine, expecting that they would seize that likewise, and thus all would be blown to atoms together.

Providence, however, otherwise directed it; the enemy, after approaching within fifty or sixty yards of the machine and seeing the magazine detached, began to suspect a Yankee trick, took alarm and returned to the island.

Approaching the city, he soon made a signal, the boats came to him and brought him safe and sound to the shore. The magazine in the meantime had drifted past Governors Island into the East River, where it exploded with tremendous violence, throwing large columns of water and pieces of wood that composed it high into the air. Gen. Putnam, with many other officers, stood on the shore, spectators of this explosion.

In a few days the American Army evacuated New York and the machine was taken up the North River. Another attempt was afterwards made by Lee upon a frigate that lay opposite Bloomingdale; his object now was to fasten the magazine to the sterns of the ship, close to the water's edge. But while attempting this the watch discovered him, raised an alarm, and compelled him to abandon his enterprise. He then endeavored to get under the frigate's bottom, but in this he failed, having descended too deep. This terminated his experiments.

* It yet remains a problem, whether the difficulty here spoken of will ever be fully obviated. Mr. Fulton's torpedoes were never fairly brought to the test of experiment, though he and his friends entertained perfect confidence that they would not be found defective in any of their operations.

Rifling Canon

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

In a translated article from the *Umschau* in your current SUPPLEMENT, Prof. Adolf Keller states that the primary reason for rifling a projectile is to keep it end on, explaining that otherwise it would bring up with its maximum surface against the line of flight, "just as a card brings up with its flat surface." I have shown that while this is true of a thin flat body, it is not true of a long fusiform body which, provided it has sufficient velocity, always tends to keep end on, e. g., a javelin or an untipped arrow.

He further states that the phenomenon known as the "drift" of a rifled projectile is due to its rolling on a heavy cushion of air underneath it, and he says this is known as the "Poisson effect." I have made some examination to discover where this term originated, what it means, and by whom it is known. Poisson published most of his papers between 1800 and 1820. Very little of the theory of gyroscopic motion was known in his time. Euler in 1780 had given his celebrated dynamic equations in gyroscopic motions and had stated he believed they were true, but that he had no idea what the motion would be. D'Alembart in 1790 said that he was thankful that, although the motions were not yet discovered, they had at least been presented in analytical form. The first complete explanation of these motions was given by Poinsot in his "Theorie nouvelle de la rotation des corps," 1834.

In Poisson's time, ranges were too short and guns too imperfect for the "drift" to be perceptible. The recognition of the drift came in with the more modern light-powered guns. As far as I can find, the discovery of, and the name, drift, came in some time during the latter half of the last century. If the term "Poisson effect," meaning, I presume, a rolling against frictional resistance, is known, it is certainly not well known. The last edition of the Encyclopædia Britannica says, "The cause of the drift is unknown, but it is evidently due to some gyroscopic action."

The latest standard work on the gyroscope in Germany is Klein & Sommerfeld's "Ueber des Theorie Kreisels." This was published in 1910, and I think any later edition improbable. In this work an attempt is made to explain the drift as a gyroscopic phenomenon. There have been several other such attempts, but they have all failed. Prof. Mach of Vienna (1906) said that the axis of a rifled projectile must execute very rapid and complicated motions with peculiar condensation of air about the point, but that their nature was not understood. I worked out this problem in 1910 and published an explanation of the drift in 1913.* I there showed that it was due to the projectile rolling sideways on a heavy cushion of air beneath, while above was a partial vacuum offering practically no frictional resistance. I also showed that the point executes peculiar cycloidal curves, being in fact a kind of double roulette. Prof. Keller states correctly in his article that the point "executes cycloidal curves," and also that the drift is due to frictional rolling on a heavy cushion of air beneath the projectile. He makes no mention of the vacuum above. But I cannot understand the relevancy or necessity of calling this action a "Poisson effect."

This is the first correct explanation of the drift I have met with, outside of my own. What particularly interests me is when and where this independent explanation originated. F. J. B. CORDEIRO.

Newton Center, Mass.

* *The Gyroscope.*

Cultivation of Living Tissues Outside the Body

THE story of the cultivation of tissues outside of the living body has already lost much of its novelty. Though we can still easily count the time in terms of months rather than years, the fact has been established so conclusively and the technic developed so successfully that the cultivation of tissues in this way has already become a familiar practice in many laboratories.

Not long ago Carrel of the Rockefeller Institute for Medical Research called attention to the condition of a piece of connective tissue kept in a condition of permanent life. It was derived originally from a piece of heart from a chick embryo. The fragment pulsated for 104 days and gave rise to a large number of connective tissue cells which have since multiplied actively. It has now been kept alive artificially for twenty-nine months, according to *The Journal of the American Medical Association*, and shows greater activity than at the beginning of that period, and is no longer subject to the influence of time. If we exclude accidents, these connective tissue cells may live indefinitely.

Keeping Steam Turbine Blades Clean

IN spite of treatment of the water used for steam purposes in a western electric plant, magnesia and lime were carried over in considerable quantities and formed a coating on the blades of the turbine that was difficult to remove and necessitated considerable work, besides the delays resulting from shutting down the machine. It was discovered, however, that kerosene would keep the blades clean, and a small hand pump for injecting it was fitted to the main steam pipe. Only an occasional dose of kerosene was necessary to keep the turbine blades clean and in good condition.

Pathology of Mental Diseases—II*

Modern Aspects of Certain Problems

By Edwin Goodall, M.D., Lond., B.S., F.R.C.P., Lond.

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 2054, Page 307, May 15, 1915

MICRO-ORGANISMS AND TOXINS IN CONNECTION WITH MENTAL DISEASES.

THE evidence furnished by the morbid histology of the brain in the acute and recent psychoses is not in favor of anything approaching a virulent toxæmia, with the doubtful exception of the condition known as "acute delirium," or "acute delirious mania"; neither does clinical evidence point to such, with the same possible exception. The temperature-pulse-respiration chart in cases of acute and recent mental disorders shows very little evidence of febrile reaction. Toxins, if any, must be of a low degree of virulence. We know, however, that various drugs which are incapable of producing the bodily disturbance of reaction which accompanies an attack of one of the specific fevers, and from this point of view are not virulent, are nevertheless able to produce very definite mental disturbance. While morbid histology affords practically no evidence of acute toxæmia in the psychoses, the changes found are quite compatible with the operation of a toxin of a milder kind. This is true, apart from dementia paralytica, for acute delirium, acute mania or melancholia, the psychoses of exhaustion. Cases of the disorders grouped under the name "dementia præcox" do not, for all practical purposes, come to necropsy in the acute and recent phase, so that, unfortunately, we have no sufficient information in respect to these. The examination of the blood in the acute and recent psychoses with the usual aerobic methods, upon the usual culture media, gives negative results.

Of all mental disorders the condition known as "acute delirium," or "acute delirious mania," is that in which we should most expect to find evidence of bacterial origin, on account of the acuteness of all the mental symptoms and the existence of grave bodily illness. The rarity of this condition has largely prevented its proper study; among the rate supported insane, at any rate, it is extremely rare, and I can only remember to have seen two or three cases in my experience of twenty-four years, and one of these was at Bethlehem Royal Hospital, which does not receive the rate supported. No significance is to be attached upon scientific grounds to any organism hitherto found in the circulation in this disease. The condition is seen in connection with typhoid and other infectious disorders, and it would therefore appear that more than one toxic agent can produce it, unless, indeed, such acts merely as a predisposing cause. Kozowsky[19] in a recent communication upon the pathology of acute delirium, states that staphylococci, diplococci, and the influenza bacillus have all been found in cases of that disorder, and this is not surprising, seeing that the state follows upon diseases in which these organisms are causal agents. I am not aware of any record of animal inoculations in connection with cases of acute delirium. The psychoses following upon specific fevers but rarely come to necropsy, so that we have no sufficient information as to the histological conditions present in the brain in such cases.

The Infection Psychoses.

This brings me to the consideration of the psychoses due to infection or intoxication processes. By these we mean disorders of mind, which amount to more than mere transitory delirium, and which supervene in the course of, or follow upon, infectious fevers, or specific diseases attended with fever. These psychoses seem to me peculiarly worthy of study, for thereby we are likely to obtain an insight into the pathogenesis of similar disorders of mind which arise without any obvious cause other than a mere deterioration of health. The infection psychoses, as they may for convenience be termed, are rarely seen in public institutions for the insane; in the first place, they are uncommon; in the second, they are mostly of brief duration. They are to be met with more frequently in the psychiatric clinics of university towns on the continent, no doubt because the patients are readily transferred thither from the ordinary medical clinics when they become troublesome.

Among the specific fevers, typhoid yielded up to recent years the largest number of these cases, but of late years influenza has been a potent factor. Friedländer gives 1.5 to 2.5 per cent as the number of cases of typhoid in which psychoses occur. Erysipelas affecting the head is probably the next most frequent cause; thereafter come malaria and pneumonia. Puerperal insanity, which belongs to the category of the infection psychoses, is in a class by itself. These psychoses, while no doubt mainly appearing after the bodily illness has manifested itself, or at its close, may appear in the form of delirium or mania before there is any fever, and are then only ascribable to a toxin, and fairly comparable to a psychosis due to some drug, to a poisonous substance used in an industry, or to ptomaines. Furthermore, the mental disorder does not by any means necessarily go with high temperatures, even when it appears after the bodily illness has become definitely established. This is the first instructive lesson I draw from a study of the infection psychoses; they illustrate (in common with insanity from drug poisoning) the ability of a toxin to cause insanity. A second instructive fact is that there is no difference in the kind of symptoms by which one can distinguish the psychosis caused by one infection or intoxication from that caused by another. The brain reacts in common, limited, well-recognized ways, irrespective of the nature of the provocative disease, it reacts to toxins; from which it appears that different toxins are capable of producing the same effects upon the cerebral cortex.

These psychoses exemplify the most diverse clinical forms; thus, acute delirious mania, mania, melancholia, states resembling closely certain of those deemed characteristic of dementia præcox, others resembling those seen in insanity with epilepsy (e.g., states of agitation, post epileptic stupor), acute confusional conditions, an exalted state resembling that seen in dementia paralytica, the syndrome of Korsákow—with its preliminary agitation and subsequent disorder of memory and attention power; above all, they take the form of acute hallucinatory insanity. In the post febrile period dementia of varying degree is shown. In short, if we exclude systematized delusional insanity, the above summary includes practically all the forms in which disease of the mind manifests itself. The specific fevers can reproduce them all, so that differential diagnosis from like mental disorders as ordinarily seen is for the time being practically impossible. The only essential difference is that in the symptomatic psychosis the disorder is commonly of shorter duration than in the so-called "endogenous" psychoses, although after typhoid and influenza varying degrees of mental defect may last for years. The above considerations naturally prompt the inquiry as to whether the forms of insanity we are accustomed to meet with, of unknown origin, are due also to toxins, exogenous or endogenous. A third point which is noticeable in connection with the infection psychoses is that one and the same provocative disease (toxin) produces different forms of mental disorder in different persons, which is presumably due to individual peculiarities.

A special reference seems desirable to the pseudo general paralysis which occurs in connection with some of the specific fevers, a point alluded to by Bonhoeffer[20] in his study of the symptomatic psychoses. As far as I am aware the pupillary reflexes are never altered, but the typical mental symptoms are reproduced, and the speech is affected, although not typically, yet in such manner as to cause difficulty in diagnosis. The knee-jerks may be exaggerated. As the pupillary phenomena are not present in every case of true general paralysis it must have been practically impossible to diagnose the simulated from the real disease by the mere symptoms in days prior to the introduction of serological, chemical, and cytological tests in respect of the cerebro-spinal fluid. A further special reference may be made to the occurrence of symptoms indistinguishable from those given as characteristic of the katatonic variety of dementia præcox. There are the stupor, flexibilitas cerea, verbigeration, echolalia, and echopraxia, stereotypy, rhythmical movements, rigidity of attitude, grimacing, mimicking, tics, and negativism; in fact, there is the entire symptom complex of this type of dementia præcox. Bonhoeffer has recently given some good descriptions of this condition following upon typhoid and pneumonia. A condition resembling katatonic stupor has been described[21] as developing in a case of pellagra; the patient apparently had a predisposition to mental disorder, as she had an attack of mania six years previously, before the pellagra showed itself. The infection psychoses furnish instances in which a given symptom complex is produced by more than one morbific agency, and therefore constitute an argument against specificity in causation of the various kinds of insanity. The abnormal constitution of the brain in individuals falling victims to mental disorder would seem to be of more importance than the exciting cause; the *irritabile* more important than the *irritans*.

The study of metabolism in mental disorders is in its infancy; methods hitherto employed are inadequate to deal with the subject. The same is true of chemical methods. The most concordant results are in respect to epilepsy with insanity, dementia paralytica, dementia præcox, and manic depressive insanity. But the changes observed up to the present are not pathognomonic.

That psychical disturbances influence metabolism is but another way of saying that the body is influenced by the mind. It having been demonstrated in a given case of insanity that a disorder of metabolism is present, the question of cause and effect remains to be determined. One of the best instances of parallelism between disorder of mind and disorder of metabolism, and one of the readiest to suggest itself, is the occurrence of glycosuria in conditions of mental agitation, or agitation with depression, such as occur in different kinds of insanity. According to Allers the periods of excitement of general paralytics and epileptics are associated with an excretion of acetone bodies. The origin of these is a matter of speculation. Then there is the phosphaturia connected with states of mental agitation. I fear that in such instances as these it is difficult to get beyond the unsatisfactory position of psychophysical parallelism.

Metabolism in Epilepsy.

The work of Rohde[22] is cited by Allers as particularly exact and critical. He finds in severe cases a disturbance in nitrogen metabolism, there being a retention of nitrogen, which reaches its maximum immediately before the fit. The pre-paroxysmal stage is also marked by the appearance of an increased quantity of ether soluble acids. The significance of this expression is dubious, and it requires explanation. The retention of *N* would appear to be the characteristic of the fit-free stage, but it is not peculiar to epilepsy, for a similar condition has been described in connection with the katatonic phase of dementia præcox and in dementia paralytica. After the epileptic seizure there is an increased excretion of *N*, which reaches a maximum at the close of a series of fits, and after the *status* there is a negative balance. Uric and phosphoric acids are also excreted in increased amounts and also lactic acid; the last is probably due to muscular contractions and asphyxia. Guide,[23] from his researches into the pathogenesis of epilepsy, also describes a profound alteration in nitrogenous metabolism.

Metabolism in Dementia Paralytica.

The study of metabolism in this disease is rendered extremely laborious and uncertain owing to the restlessness of the patients and the difficulty of obtaining 24-hour specimens of the excreta. In 1908 Kauffmann[24] wrote a monograph embracing the study of a few cases, but the value of his laborious work is much diminished by reason of its unsystematic and diffuse nature. He brings out the point of the disturbance of the water balance; the balance is negative, the loss of water partly accounting for the enormous loss of weight in this disease. Other workers, as Allers refer to the great variations in the water balance. There are, further, great variations in weight not dependent upon food intake. The loss of weight is not counterbalanced by subcutaneous infusion of salt solution. The process of heat regulation is also disturbed. For the temporary febrile states which one observes in general paralytics, if the temperature is taken regularly every three or four hours, and for which there is no apparent cause, Kauffmann suggests, by way of explanation, the accumulation of intermediate products of metabolism. The fever thus produced brings about increased oxidation and so becomes extinguished. These febrile states have commonly been explained upon a theory of infection and not upon one of auto-intoxication. In dementia paralytica, and, in fact, in all psychoses leading to dementia, products of degeneration of nervous tissues (*abbau produkte*) are to be found in the glia cells, and cells of

[19] Kosowsky: Allgemeine Zeitschrift für Psychiatrie, Band lxviii, Heft 4, 1911.

[20] Bonhoeffer: Die Symptomatischen Psychosen, 1910.

[21] Cole: *The Lancet*, September 6th, 1913, p. 717.

[22] Rohde: Deutsches Archiv für Klinische Medizin, Band xcv., 1908.

[23] Guidi: Rivista Sperimentale di Freniatria, vol. xxxiv., 1908.

[24] Kauffmann: Bieträge zur Pathologie des Stoffwechsels bei der Psychosen, G. Fischer, 1908.

the adventitia of blood vessels, in considerable, sometimes in enormous, amount. These have commonly been looked upon as of a fatty nature, but on insufficient evidence. It remains to be seen what they really are from a chemical standpoint and, by experiment, what noxious influence they may have.

Recently Allers[25] has published the results of a prolonged research in the metabolism of dementia paralytica, his chief conclusions being that endogenous protein metabolism is increased, as evidenced by the negative nitrogen (and sulphur) balance, with uniform intake or nitrogen. Nevertheless, the metabolic changes are not carried out to their end stages; they are quantitatively greater but qualitatively deficient—incomplete. These definite metabolic changes, occurring at any rate in certain phases of the diseases, are regarded as showing the existence of a general, not merely a cerebro spinal, disorder. Before their significance for dementia paralytica can be estimated control experiments in other organic diseases of the nervous system are necessary, but these, as Allers points out, are as good as nonexistent. It is highly significant that considerable metabolic disturbance may be present with but small loss in weight, for in persons prone to mental disorder slight losses in weight frequently go with a definite disturbance of the mental balance.

Metabolism in Dementia Præcox.

The katatonic form has been carefully investigated by Rosenfeld,[26] the four cases he worked with being in a stuporose state; they were upon a fixed diet and fed by tube. The positive result was that *N* was retained in considerable quantity in all cases, even in periods when insufficient food was taken and the body weight sank. The nitrogen he believed to be in the form of available free protein, and for reasons he states. Pighini[27] obtained a like result, but in the chronic phase of the disease (which is characterized by dementia, negativism, tics, and stereotypy), and phosphorus was also excreted in diminished quantity, while excretion of calcium and sulphur was increased. In the acute phase, or with exacerbations, characterized by motor restlessness, impulsiveness, and sensory excitement, the *N* balance was negative, and sulphur and phosphorus (especially neutral sulphur) were excreted in increased quantity, which Pighini ascribes to increased nucleo protein katabolism. In the final, chronic stage, characterized by dementia—instances of which so largely help to fill asylums—the chemical exchange is physiological, as one would expect. In the active phase of this disease, as in dementia paralytica, there are great variations in weight, not wholly dependent upon food intake; the latter may be abundant and absorption good, and yet the patient loses weight. The work of Rosenfeld goes to show that these variations, as in dementia paralytica, are due largely to disturbance in the water balance.

Grafe,[28] in 18 cases of stupor occurring in different forms of mental disorder—such as the katatonic form of dementia præcox, dementia paralytica—found a definite lowering of metabolism, especially in the dementia præcox cases. The production of heat was diminished to 39 per cent below normal. Apart from myxœdema, such an extreme reduction is believed to be very rare. In these cases there was no marked emaciation and no hypotonicity of muscle. And such reduction is, according to Grafe, not found in chronic under nutrition. From the researches of Borstein, Bornstein and Oven, and Grafe it follows that the exchange of energy, as estimated in calories, is very considerably diminished, and below the limit of physiological variation, in some cases of dementia præcox.

Extremely little experimental work has been done in the metabolism of manic depressive insanity.

The Dyestuff Industry

According to the daily press, the manufacturers of both cotton and woolen goods and other color-using industries in this country are being put to considerable difficulties in securing a sufficient supply of dyestuffs. One or more of these sensational articles stated that there was a possibility of this famine in dyes forcing textile mills to shut down and throw about 400,000 employees out of work. Aniline dyes are produced principally in the countries in which war now rages, and the chief source of the material used in the United States has been Germany. The interference with Germany in shipping dyes into this country at the outbreak of the war immediately awakened serious apprehensions in the minds of some of those who had a knowledge of our dependence on Germany for coal-tar dyes.

The more recent articles on this subject published in the trade and scientific papers dealing with dyes, textiles and all industries depending in whole or in part upon German coal-tar products, refer to the situation as far less perplexing than the daily press originally seemed to indicate. In an article headed "Contributions of the Chemist to the Industrial Development of the United States—A Record of Achievement," by Bernard C. Hesse, *The Journal of Industrial and Engineering Chemistry*, April, 1915, raises the question: *Is* there a shortage? This question is not answered affirmatively, but Mr. Hesse goes on to show that the present difficulty, for instance, in the textile industry does not lie in the lack of dyes, but that the real cause goes deeper than the dyestuff question, because the mills cannot sell their goods. But, he says, if they could sell their goods in this country or elsewhere, they might buy more dyestuffs than they do.

Mr. William W. Skiddy of the Stamford Manufacturing Company, Stamford, Conn., according to the New York *Times* of April 11th, 1915, says:

> "I think the excitement which has been caused by many of these articles is uncalled for, for the reason that there are dyestuffs in considerable quantities made in the United States. There are some who manufacture anilines in the United States, and there are also large manufacturers of vegetable dyes in this country, such as logwood, fustic, hypernic, etc. These dyes were made for a great many years prior to the knowledge of any aniline colors, and were universally used by the textile manufacturers and others who had to use colors."

About sixty years ago the United States manufactured practically all dyestuffs used in this country, but those colors were of vegetable origin. The dye-wood extract industry was developed here, but our methods were immediately copied by the Europeans, and many factories for making dyestuffs soon sprang up in England, France, Germany, Italy, and Russia, where labor was cheaper than in the United States, and the finished product could be imported for less than it could be made here. Another serious blow to the American dye industry was the rapid development of coal-tar dyes in Germany. Enormous quantities of these colors of almost unlimited varieties are now made in Europe and practically all of them have been introduced and are now in great demand among American color-using concerns. These are at present about 1,200 shades or combinations and they are still increasing.

It is gratifying to learn from various reliable sources that the domestic manufacturers by running full time can satisfy the normal requirements of the color-using concerns in this country. It is understood, of course, that American manufacturers cannot now make a number of the shades which have been recently produced in Germany, nor can it be determined what per cent of the color actually made available for use in this country will be of coal-tar origin. German dyestuffs will continue to come in and the position of the domestic manufacturer of coal-tar dyes may remain unchanged until the tariff laws are modified.

There is a fair possibility, however, that vegetable dyes are coming into their own again. It is claimed that the adjustment of the machinery in dyeing plants for the use of vegetable as against coal-tar dyes is not very great, as is shown by the fact that a number of textile manufacturers use both kinds of dyes, depending upon the material to be colored. Another factor in favor of the possible increased use of the vegetable dye is that the producers of this class of goods are fully equipped and can procure the raw material at the present time under the most favorable circumstances. The woods come chiefly from tropical America, and since the shipment of these woods to Europe is considerably curtailed, they are now offered in the American markets at figures below the normal.

While the use of dyestuffs in general has increased enormously in recent years, that obtained from dyewoods has decreased. From 1860 the quantity and value of dye-woods imported steadily increased until about 1880, when the coal-tar dyes began to come into general use. During the succeeding decades the amounts imported fell abruptly. The total value of dyestuffs (logs and extracts) used is given in the following table:

Year.	Value.	Year.	Value.
1860	$838,186	1890	$1,725,167
1870	1,337,093	1900	862,462
1880	1,808,730	1910	566,377

Since 1910, the annual imports of dye-woods amounted to about $500,000. Among the woods used logwood stands first. It is of West Indian origin and is adapted particularly for coloring leather, and for dyeing textiles it is also considered by some as superior to all artificial dyes. Fustic, which also comes from the West Indies, stands second in importance among the woods used for extracting a dye. It is used principally in dyeing woolen goods a bright yellow color. Young fustic, camwood, barwood, sanders, sappan, and the Brazils come into this country in varying quantities. In addition to these foreign woods, vast quantities of oak bark are used, as well as a long list of other vegetable tissue of minor importance. But this can hardly ever be satisfactory. Not only are most coal-tar dyes cheaper than vegetable dyes, but the variety of shade is far greater.

[25] Allers: Zeitschrift für die gesamte Neurologie und Psychiatrie, Band xvii., Hefte 1 and 2, 1913.

[26] Rosenfeld: Allgemeine Zeitschrift für Psychiatrie, Band lxiii., Hefte 3 and 4.

[27] Pighini: Rivista Sperimentale di Freniatria, vol. xxxii., 1906, and vol. xxxiii., 1907.

[28] Grafe: Deutsches Archiv für Klinische Medizin, vol. cii., Heft 15, 1911; Zeitschrift für Physiologische Chemie, vol. lxv., Heft 21, 1910.

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Table of Contents

	PAGE
Various Forms of the Periscope.—3 illustrations	322
Battery Operated Locomotive Headlights	322
Ozone Sterilizing Plant	322
The Romance of Motion Pictures.—By C. Francis Jenkins	323
The Measurement of Distances in War.—11 illustrations	324
Fuel Oil	325
Harvest Forecast for 1915	325
Atoms and Ions.—IV.—By Sir J. J. Thomson.—1 illustration	326
How Much Albumen is Needed in Our Diet	327
Measurements of Radium	327
European Aeronautical Laboratories.—I.—By A. F. Zahm.—5 illustrations	328
A Vibrator Electrometer	330
Removing Tar From Gas	330
The Telephotographic Apparatus of Georges Rignoux.—By R. Arapu.—7 illustrations	331
The Coolidge Tube in Metallurgical Research.—By Dr. Wheeler P. Davey	331
Wire Winding Big Guns for Uncle Sam.—By Chester L. Lucas.—6 illustrations	332
Correspondence	333
Rifling Cannon	334
Cultivation of Living Tissue Outside the Body	334
Keeping Steam Turbine Blades Clean	334
Pathology of Mental Diseases.—II.—By Edwin Goodall	335
The Dyestuff Industry	336